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GOLDEN EARS

ANOTHER KIQ PRODUCTION

Instruction Manual

BY DAVID MOULTON
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INTRODUCTION

Welcome to the Golden Ears audio eartraining program. This manual and the accompanying CDs are the product of close to two decades of studio experience as well as teaching recording engineering and production at a number of institutions. The volume(s) you have purchased, Volume 1: Frequencies, and/or Volume 2: Effects and Processing, are the cornerstones of an anticipated series of audio eartraining drill sets. Each volume is an independent course, designed to condense years of hands-on experience into a matter of weeks.

As you work your way through the exercises, you'll find yourself hearing recordings in a completely new light. Furthermore, you may expect these CDs to provide years of service as a reference. Long after mastering the exercises, you'll be able to give your ears an occasional "workout" to maintain your valuable skills.

About this manual: Many people have an aversion to reading manuals. However, if you want to start right in with the CDs, go ahead. Simply put on the first CD, play it, and try to figure it out. When you get confused or bored, or just feel like reading something, that's when you should read the manual.

On the other hand, the manual and the CDs are designed to work together. We haven't wasted valuable CD recording time with information that could be better presented in this manual. I've tried to put as much useful material as possible in this manual, so you might want restrain your initial urge to leap right in.

Pages have been printed on the right side only to leave space for notes; you can either go straight to the drills or read this manual in its entirety first.

Why develop Golden Ears? The auditory challenges facing today's musicians and recording, mixing, and mastering engineers are really substantial.

The performance baseline for audio technology has improved dramatically over the past twenty years. From the recording studio to the listener's loudspeakers, we have come to expect recordings of superb acoustic instruments, really convincing sampling and synthesis, mega-awesome processing capabilities, and so forth. We now expect audio quality that includes flat frequency response, noiseless and distortionless audio signals, and superb time and spatial resolution. To get these things, we need extremely well-developed critical listening skills.

Golden ears are skilled enough to discern, measure, analyze, and express the physical qualities of musical sounds accurately. Once you have them, you will be able to listen to recordings with more sensitivity and awareness, as well as a lot more enjoyment. This is particularly true when you are engineering or producing music and have to make critical decisions about it.

Golden ears enable us to realize the full potential of our audio systems in the production of recorded music. This CD set provides a crucial tool for developing those ears quickly and easily. It provides a base of auditory experience and knowledge that is essential for working with modern recorded music. Working through these drills and using them as refreshers from time to time will permit you to gain and maintain the equivalent of five to ten years of critical listening experience in a matter of weeks.

As you get good at these drills, you will be able to pinpoint problems rapidly and make useful decisions about how to deal with various audio and musical problems, instead of having to resort to the more traditional "keep turning knobs until something sounds good" approach, with its accompanying hype ("I'm just resetting the critical phase offsets. I'll be with you in a second. There, how's that? Ya gotta love it!"). You will come to know, by ear, how the audio energy is distributed across the spectrum, approximately how loud two sounds are relative to each other, the kinds of signal processing going on, and so on. Almost as important, you will be able to easily detect when others are reduced to random knob-twiddling and hype.

Dave Moulton

USING THE CDS

Doing the exercises

Calibrating the system

Calibration consists of a brief sequence of pink noise and five tones. The pink noise will be used for setting playback level, and the tones will be used to confirm the spectrum range of your playback system. The calibration material is at the ***end*** of each CD. This way you don't have to listen to it each time you start up.

First, you will set your playback level. It is fairly important ***not*** to adjust levels while you are doing the drills (because of the variation in level vs. spectrum at different loudness levels— the so-called Fletcher-Munson curves). You will listen to the pink noise to do this.

Then you will check out the spectrum using the tones. You should probably have all of your tone controls off or set at flat, unless you are *really* attached to some listening setting that you like an awful lot. Also, if you have a loudness compensation button on your playback preamp or receiver, you should turn it off.

Setting Playback Level Using Pink Noise

The pink noise is played at three different levels. The first level is the "nominal listening level." It will be at the same loudness as the slates and drills when nothing is boosted or cut. You should set the your playback level so it is comfortably medium loud, subject to the considerations of the next two pink noise levels (75 dB SPL might be nice, if you have an SPL meter handy). The second level is 6 dB louder than the nominal listening level and it is about as loud as any of the drills ever get. You should verify that (a) it doesn't cause your speakers or the neighbors any distress and (b) it is comfortable, if somewhat loud. The third level is another 6 dB louder (12 dB above

the nominal level), and represents the maximum level that your playback system will ever need to handle for these drills. You should simply confirm that the system doesn't show signs of distress (bad odors, crackling noises, obvious distortion, etc.) at this level. If it does, you will need to turn down the playback level until it can be reproduced with ease by your system.

Checking the Response of Your System Using the Tones.

The last track on the CD is about 20 seconds long and consists of five sinusoidal tones, in the following order:

1 KHz., 10 KHz., 100 Hz., 15 KHz., 40 Hz.

These are at the nominal listening level. Each tone goes on for about five seconds.

You should play back the five tones. If you can't hear 1 KHz., 10 KHz. or 100 Hz. at the nominal listening level, there is a serious problem with your monitoring system that has to be dealt with before you can proceed. The loudnesses of these tones may sound different to you— so long as the differences are not extreme, you are OK. The 15 KHz. and 40 Hz. tones represent extremes of the audio spectrum, both for the equipment and for our hearing. Expect them to be significantly softer in level. They may even be inaudible or barely audible. If so, you can proceed, but you should be aware that you may have a little trouble hearing the extremes of the spectrum.

You are now ready to begin the drills.

There are two basic types of drills: sets of examples of changes in loudness of octave bands of the audio spectrum and critical (A/B) comparisons of two versions of a recording.

The Equalization Drills

The equalization drill sets each consist of ten examples. Each example is about ten seconds long and consists of either pink noise or music. The example begins with the sound played normally. After about three seconds, the sound is altered by boosting or cutting the amplitude of one or more octaves in the spectrum, using a graphic equalizer. After about four seconds of equalized sound, the sound is returned to its normal state. Your task is to identify which octaves of the spectrum were boosted or cut.

To help you, there is a warmup drill preceding the drill set to let you get the "sound" of the various octaves "in your ears." Also, the beginning drill sets restrict the octave ranges being changed into groups called "low" (octaves one through five, 31—500 Hertz), "mid" (octaves four through eight, 250—4000 Hertz), and "high" (octaves six through ten, 1 KHz.—16 KHz.). This greatly simplifies your decision-making at the beginning.

Doing the Equalization Drills

Calibrate your system (refer to the previous section) and get yourself set on the median plane (equidistant from each speaker). You will find the answers to these exercises at the end of this chapter and answer sheet templates at the end of the manual. Start at the beginning, with Drill Set 1 of the first CD of Volume 1.

- Play the Drill Set, which will include the warmup drill. While listening to the warmup drill, try to memorize the sound of the octaves being boosted. Then listen to the ten examples of the drill set. Guess which octave is being boosted and write it down, expressing it as a center frequency (i.e. "125 Hz.").

When you complete the drill set, hit pause on the CD player, and skip back to the beginning of the drill set. The CD will cue up just after the slate for the drill set itself, at Example 1.

Frequencies

• Play the drill set a second time to double check your answers. Pause and skip back again. Now take out the answer sheet that is included in the CD booklet, and play back the drill set a third time, listening while writing down the correct answers on the answer sheet.

• Pause again at the end to score yourself. If you guess the correct octave on an example, give yourself 10 for that example. For each octave "off" you are, take away 1, so that if you guessed 1 KHz. (Octave 6) and the right answer was 250 Hz. (Octave 4), your score is 8. Total up your scores for all ten examples. A perfect score for a drill set is 100. If you simply wrote down random answers, you should get around 40 points. What I've found is that scores of between 85 and 95 are typical for single octave bands of music being boosted or cut, once you get the hang of it.

• Now go ahead to Drill Set 2. Once again, listen to the warmup drill and play through the ten examples while guessing which octave is boosted. Listen to the examples a second time to reconsider your answers. Then play back the examples while looking at the correct answers and entering them on the answer sheet. Pause and score yourself.

• Go ahead to Drill Set 3 and repeat.

• Quit for the time being. It is counterproductive to work on these exercises when your ears are tired.

• Start your second session by repeating the last drill set of the previous session. Again, do three drill sets, listening to each drill set twice before checking the answers. Always ***listen*** to the drill set while you check the correct answers, and write those correct answers down to help you learn to "visualize" in your mind the correct answer related to the sound.

Work through both CDs in Volume 1 this way, repeating the last drill set from the previous session and adding two new drill sets.

Drill Sets 1-3 involve pink noise being boosted in low, middle and high

regions of the audio spectrum.

Drill Sets 4-6 use musical material instead of pink noise, again boosting in low, middle and high regions of the spectrum.

Drill Set 7 will introduce cuts, again starting with pink noise. You will probably find it is easiest to identify the frequency of the octave being cut when it is being brought back in at the end of the example.

Drill Set 13 begins to deal with the entire spectrum, so that your range of possible choices is much larger. If you find yourself getting confused by too many choices, feel free to go back and review any of the first 12 drill sets in order to get your bearings.

Drill Set 5 on the second CD introduces the possibility that a given octave is ***either*** boosted ***or*** cut. As you do these drills, you must indicate on the answer sheet whether the octave in question is boosted (use a "+") or cut (use a "-"). When you score this or later drill sets where you have to guess whether the octave is boosted or cut, if you guess wrong, take away two more points, so that if you had guessed 1 KHz. boosted when in fact 250 Hz. was cut, your score would be 6.

• When you have worked your way through both CDs of Volume 1 this way, you should then try CD 1 on random play. Now you will do the drill sets without a warmup and without knowing what the drill set is going to be about. ***Always*** listen again while writing down the correct answers.

• When you have become proficient at hearing the drills on CD 1, switch to CD 2 and play it randomly. To provide a little more challenge, try listening only once to the drill set before checking with the correct answers. CD 2 can be played lots of times (probably close to an infinite number— although why you would do that I honestly do not know) before you will know it well enough to be able to remember the answers.

Through all of this, limit your sessions to three or, at the most, four drill sets.

How these drills were made

The equalization drills were produced using Pink Noise from an Ivie Pink Noise generator and Compact Disc recordings in a variety of musical styles. Although these drills are pretty close to Fair Use under the copyright law, we have obtained permissions from all owners of the recorded material, and would like to thank them by encouraging you to support them by buying their records. See the credit list for a complete listing of all recordings used.

Both the Pink Noise (in mono) and the recordings (in stereo) were passed through a UREI 10-band graphic equalizer and then recorded directly to hard disk via Digidesign's Pro Tools for editing and assembly. The graphic equalizer was set flat and for each exercise the appropriate octave band was boosted or cut by the appropriate amount (12 dB, or the limit of travel, for Volume 1). In the music recordings, both channels were treated identically.

I determined which band(s) to boost or cut by the use of a random number generator, subject to the following limits: I never did the same thing twice in a row, and I ***excluded*** "no change" as a possible answer. Because the selection was random, don't expect that all octave bands must be included in any drill set, or that you can *anticipate* what we are going to do next. I wasn't trying to fool you or play mind games.

After assembly editing of all the drills and slates, I got bored with the slates and decided to add signal processing to an occasional slate, for amusement. The processing varies from slate to slate and it's there to give you something else to do while improving your mind.

The slate for each track actually appears at the ***end*** of the warmup drill, so that you may listen 'blind' to each track.

VOLUME ONE

Hearing the Audio Spectrum

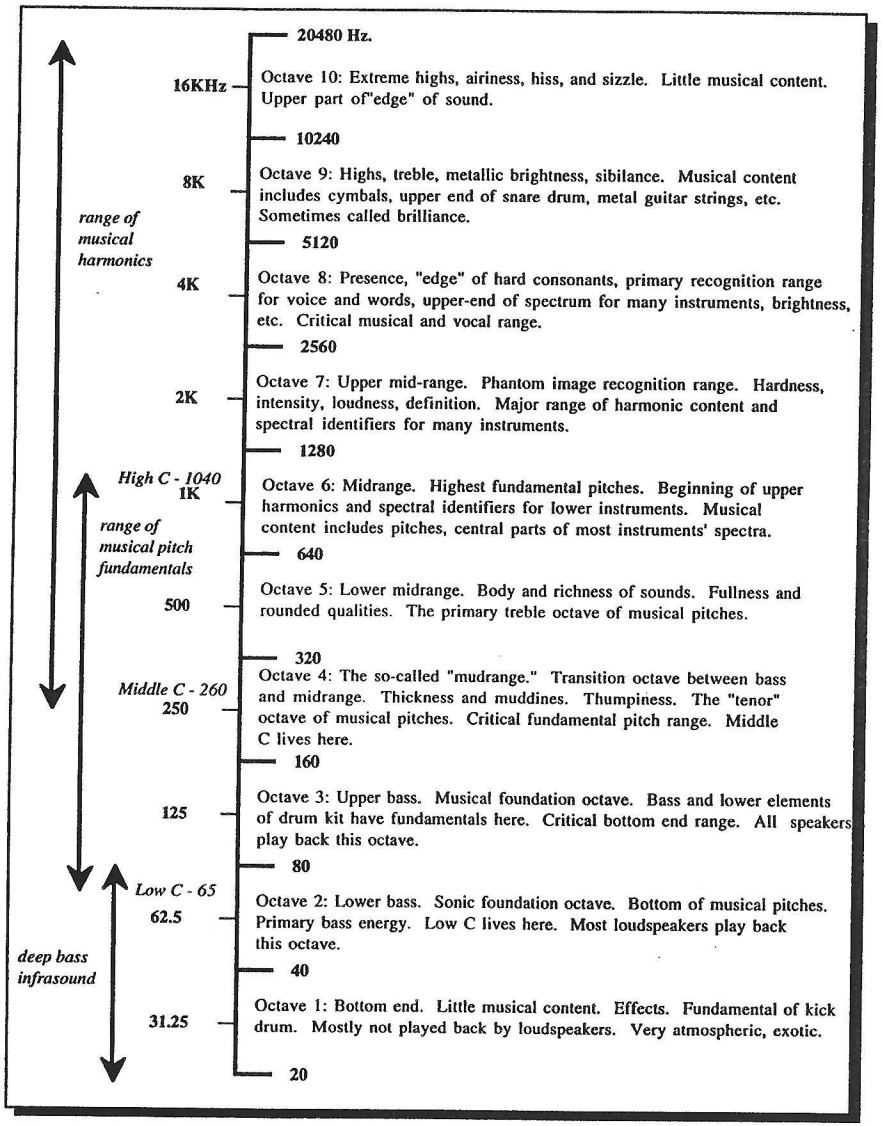
20480 Hz.
16KHz
Octave 10: Extreme highs, airiness, hiss, and sizzle. Little musical content. Upper part of"edge" of sound.
10240
8K
Octave 9: Highs, treble, metallic brightness, sibilance. Musical content includes cymbals, upper end of snare drum, metal guitar strings, etc. Sometimes called brilliance.
range of musical harmonics
5120
4K
Octave 8: Presence, "edge" of hard consonants, primary recognition range for voice and words, upper-end of spectrum for many instruments, brightness, etc. Critical musical and vocal range.
2560
2K
Octave 7: Upper mid-range. Phantom image recognition range. Hardness, intensity, loudness, definition. Major range of harmonic content and spectral identifiers for many instruments.
1280
High C - 1040
1K
Octave 6: Midrange. Highest fundamental pitches. Beginning of upper harmonics and spectral identifiers for lower instruments. Musical content includes pitches, central parts of most instruments' spectra.
range of musical pitch fundamentals
640
500
Octave 5: Lower midrange. Body and richness of sounds. Fullness and rounded qualities. The primary treble octave of musical pitches.
320
Middle C - 260
250
Octave 4: The so-called "mudrange." Transition octave between bass and midrange. Thickness and muddines. Thumpiness. The "tenor" octave of musical pitches. Critical fundamental pitch range. Middle C lives here.
160
125
Octave 3: Upper bass. Musical foundation octave. Bass and lower elements of drum kit have fundamentals here. Critical bottom end range. All speakers play back this octave.
80
Low C - 65
62.5
Octave 2: Lower bass. Sonic foundation octave. Bottom of musical pitches. Primary bass energy. Low C lives here. Most loudspeakers play back this octave.
deep bass infrasound
40
31.25
Octave 1: Bottom end. Little musical content. Effects. Fundamental of kick drum. Mostly not played back by loudspeakers. Very atmospheric, exotic.
20

Figure B: The Ten Octaves of the Audio Spectrum. Given both in terms of the ISO center frequencies (on left) and boundary frequencies. Each octave has its own particular qualities, musically, acoustically and psychoacoustically.

Perfect pitch is a highly developed auditory memory that allows you to identify a given pitch by ear alone. A few people have that memory capability naturally. Most of us can learn it, if we want to. The Golden Ears course does something related to perfect pitch training, in that it teaches and develops your memory for *regions* of the audible spectrum. Where the musician with perfect pitch can say "That note is an E-flat," you will be able to say, "The treble is boosted by 3 dB at 2.5 KHz." This latter ability turns out to be extremely useful. In essence, it gives you the ability to tune your audio system or recording studio, which can be thought of as a musical instrument.

You will learn to identify the qualities of frequencies throughout the audible spectrum, using pink noise and musical examples. This ability is developed gradually. In Volume 1, you will learn the sound of each of the ten octaves in the spectrum. These are the raw materials of frequency out of which we build music, and each one has its own particular characteristics, quality, and musical significance. In recording, handling these octaves is one of our primary tasks.

Golden Ears Volume 1, CD 1 - Frequencies answers

This is the first CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying one-octave bands of pink noise or recorded music that have been boosted or cut using a conventional graphic equalizer. The first 12 drill sets involve only a portion of the audio spectrum, making it easy for you to concentrate on learning the sound of a particular portion of the spectrum. Drill sets 13 and 14 involve the entire audio spectrum.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the various octaves of the spectrum.

Please note that Track Cue points occur after the identifying slates and warm-up drills, so that you may select drills at random to test your hearing ability as it develops.

All of us at KIQ Productions gratefully acknowledge and thank the various record companies that have allowed us to use their recorded materials. We urge you to support these companies and buy their records.

Credits

Created and produced by David Moulton
Engineer: Robin Coxe-Yeldham
Assistants: Bill Lee and Dan Ricci
Rights to recorded material granted by:

Boston Skyline Records, Boston, MA
SOL Records, 51 Maxfield Street, West Roxbury, MA 02131 Tel. 617-327-6470
JVC Records, Los Angeles, CA

Some insights about these octave ranges:

- Various musical functions exist in various different ranges. Octaves 2-5 contain the musical fundamental pitches. Octaves above those contain the overtones that are central to defining timbre for musical sounds.

- Overall apparent loudness is very much a function of how these octaves are treated. This is particularly true for octave 7, which contains the frequencies our ears are most sensitive to.

Later on, we are going to release additional materials you can use to learn to identify (to 3 dB accuracy) the magnitude of a change in level of any octave of the spectrum. This skill will then be extended to 1/3 octave resolution.

Another useful direction we will also offer allows you to practice hearing two different octaves of the spectrum modified simultaneously. When you have mastered this, you will have acquired the fundamental ability to mentally scan the audible spectrum and "hear out" spectral elements by ear. You will begin to be able to hear and identify full equalization curves, not to mention the harmonic structures of individual musical sounds. Finally, you can work on drills involving three spectral regions modified simultaneously!

Answer Sheet Templates for Volume 1:

ANSWERS CD ONE

Drill Set 1

Format: *Lowest five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	63 Hz.	500 Hz.	31 Hz.	250 Hz.	125 Hz.	500 Hz.	125 Hz.	250 Hz.	500 Hz.

Drill Set 2

Format: *Middle five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	2 KHz.	250 Hz.	500 Hz.	250 Hz.	500 Hz.	1 KHz.	4 KHz.	500 Hz.	2 KHz.

Drill Set 3

Format: *Highest five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	1 KHz.	8 KHz.	2 KHz.	8 KHz.	4 KHz.	8 KHz.	1 KHz.	16 KHz.	2 KHz.	1 KHz.

Drill Set 4 *(Music: Tom Coster: "Gotcha!!," JVC 2015-2, Band 1.)*

Format: *Lowest five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	63 Hz.	250 Hz.	500 Hz.	31 Hz.	500 Hz.	63 Hz.	125 Hz.	63 Hz.	500 Hz.	250 Hz.

Drill Set 5 *(Music: Signs of Life: "Signs of Life," SOL Records, Track 1)*

Format: *Middle five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	250 Hz.	1 KHz.	250 Hz.	500 Hz.	250 Hz.	4 KHz.	250 Hz.	2 KHz.	250 Hz.	4 KHz.

Drill Set 6 *(Music: Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, Band 1)*

Format: *Highest five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	16 KHz.	1 KHz.	4 KHz.	1 KHz.	8 KHz.	2 KHz.	8 KHz.	4 KHz.	16 KHz.

Drill Set 7

Format: *Lowest five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	63 Hz.	500 Hz.	31 Hz.	125 Hz.	500 Hz.	125 Hz.	31 Hz.	250 Hz.	63 Hz.

Drill Set 8

Format: *Middle five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	1 KHz.	250 Hz.	500 Hz.	4 KHz.	500 Hz.	1 KHz.	250 Hz.	2 KHz.	4 KHz.

Drill Set 9

Format: *Highest five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	16 KHz.	1 KHz.	2 KHz.	4 KHz.	8 KHz.	1 KHz.	16 KHz.	8 KHz.	16 KHz.

Drill Set 10 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 1)*

Format: *Lowest five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	250 Hz.	63 Hz.	500 Hz.	63 Hz.	125 Hz.	250 Hz.	125 Hz.	250 Hz.	63 Hz.	500 Hz.

Drill Set 11 *(Music: Kevyn Lettau: "Simple Life," JVC 2016-2, Band 1)*

Format: *Middle five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	2 KHz.	1 KHz.	4 KHz.	250 Hz.	500 Hz.	250 Hz.	1 KHz.	500 Hz.	250 Hz.

Drill Set 12 *(Music: Bruno Råberg: "Pentimento," BSD 115, Band 1)*

Format: *Highest five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	8 KHz.	16 KHz.	4 KHz.	8 KHz.	2 KHz.	4 KHz.	16 KHz.	4 KHz.	2 KHz.	4 KHz.

Drill Set 13

Format: *All ten one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	31 Hz.	16 KHz.	1 KHz.	2 KHz.	63 Hz.	4 KHz.	31 Hz.	4 KHz.	63 KHz.	4 KHz.

Drill Set 14 *(Music: Don Grusin, "Don Grusin," JVC JMI 2010-2, Band 1)*

Format: *All ten one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	4 KHz.	63 Hz.	500 Hz.	8 KHz.	4 KHz.	500 Hz.	16 KHz.	63 Hz.	125 Hz.

ANSWERS CD TWO

Drill Set 1

Format: *All ten one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	125 Hz.	8 kHz.	125 Hz.	500 Hz.	16 KHz.	4 KHz.	31 Hz.	250 Hz.	31 Hz.

Drill Set 2 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 2)*

Format: *All ten one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	2 KHz.	125 Hz.	63 Hz.	250 Hz.	2 KHz.	63 Hz.	250 Hz.	2 KHz.	31 Hz.	2 KHz.

Drill Set 3

Format: *All ten one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	1 KHz.	63 Hz.	500 Hz.	2 KHz.	4 KHz.	63 Hz.	250 Hz.	4 KHz.	63 Hz.	2 KHz.

Drill Set 4 *(Music: Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, Band 2)*

Format: *All ten one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	125 Hz.	16 KHz.	4 KHz.	63 Hz.	2 KHz.	250 Hz.	31 Hz.	1 KHz.	2 KHz.

Drill Set 5

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+31Hz.	+63Hz.	-500Hz.	+31Hz.	-16KHz.	+31Hz.	-125Hz.	+4KHz.	-31Hz.	-250Hz.

Drill Set 6

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-8KHz.	+4KHz.	+63Hz.	+500Hz.	+4KHz.	-8KHz.	+500Hz.	+1KHz.	-31Hz.	-250Hz.

Drill Set 7

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+16KHz.	-16KHz.	-31Hz.	-4KHz.	+500Hz.	+8KHz.	-4KHz.	-63Hz.	+2KHz.	-4KHz.

Golden Ears Volume 1, CD 2 - Frequencies continued

This is the second CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying one-octave bands of pink noise or recorded music that have been boosted or cut using a conventional graphic equalizer. The first four drill sets each are restricted to either boosting or cutting. The remaining ten sets involve a mixture of boosting and cutting octaves across the entire audio spectrum.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the various octaves of the spectrum.

Please note that Track Cue points occur after the identifying slates and warm-up drills, so that you may select drills at random to test your hearing ability as it develops.

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JVC Records, Los Angeles, CA

VOLUME TWO

Effects and Signal Processing

Drill Set 8 *(Music: Signs of Life: "Signs of Life," SOL Records, Track 2)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+8KHz.	-4KHz.	-500Hz.	-2KHz.	+16KHz.	-16KHz.	-250Hz.	+63Hz.	-31Hz.	-8KHz.

Drill Set 9 *(Music: Bruno Råberg: "Pentimento," BSD 115, Band 2)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	+250Hz.	-500Hz.	+250Hz.	-125Hz.	+500Hz.	+125Hz.	-63Hz.	-500Hz.	-250Hz.

Drill Set 10 *(Music: Tom Coster: "Gotcha!!," JVC 2015-2, Band 2.)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	+16KHz.	-250Hz.	+31Hz.	+16KHz.	-1KHz.	-4KHz.	+500Hz.	+2KHz.	+125Hz.

Drill Set 11 *(Music: Trio Sonata: "Encore!", BSD 114, Band 1)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-500Hz.	+4KHz.	-125Hz.	+1KHz.	+125Hz.	-8KHz.	-250Hz.	+16KHz	-1KHz.	-4KHz.

Drill Set 12 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 4)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+500Hz.	+125Hz.	+1KHz.	-500Hz.	+8KHz.	-125Hz.	-500Hz.	+2KHz.	+63Hz.	-8KHz.

Drill Set 13 *(Music: Seymour Hayden: "Scarlatti by Hayden", BSD 112, Band 1)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	-125Hz.	+250Hz.	+125Hz.	-500Hz.	+4KHz.	+500Hz.	-31Hz.	+8KHz.	+63Hz.

Drill Set 14 *(Music: Don Grusin, "Don Grusin," JVC JMI 2010-2, Band 8)*
Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-8KHz.	-125Hz.	-500Hz.	+1KHz.	-16KHz.	-31Hz.	-2KHz.	+250Hz.	+125Hz.	-63Hz.

The A/B Drills

Each A/B drill set consists of five examples. Each example is a pair of recorded excerpts of music. The first recording (A) is the "reference" and the second (B) is a clone of the first with some sort of signal processing or audio anomaly added. Your task is to identify the signal processing applied to the B recording.

To assist you, we have limited the number of possibilities to a menu of 31 possible signal processing changes, grouped into six families: amplitude change, distortion, compression, equalization, stereophony and time-delay/reverberation. Also, we have included "no change" as an additional answer, just to keep you honest. Instead of a warmup drill, the first half of CD 3 demonstrates all of these effects for you. The balance of CD 3 and all of CD 4 are A/B drills.

The A/B drills are an effort to instill critical listening paranoia in you and to teach you how to hear and identify small differences between two versions of the same recording. This is an absolutely essential skill for certain aspects of record production work. Trust me! You don't want to be the one to explain that you didn't notice that the reverb return on the right channel dropped out in the middle of the third song and that because you didn't notice it you went ahead and OK'd it for a production run of 5,000 CDs. Such explanations are upsetting for all concerned and it is better for your basic life quality if you don't have to be involved in many such explanations, particularly as the person who has to do the explaining!

Doing the Drills

- Calibrate your system. Answer sheet templates are at the end of this chapter and answer sheet templates at the end of the manual.

- Listen to the demonstration examples on CD 1 of Volume 2. There are thirty-one of them, in six families. Go over them until you are quite sure you can hear the differences described. You will probably find

some of them quite easy, while others will be a little harder. Devote an entire listening session just to the demonstration examples. It will take between 45 minutes and an hour.

- Then, in your next session, cue up Drill Set 1 on CD 1 (beginning with Track 8). Listen to the five A/B examples. For each example, guess both which family of signal processing was used, and which specific menu item it was. On some examples, only one channel is changed. Guess which channel (note that it doesn't have to be the same as the channel used in the demonstration examples).

- After you have completed the five examples, put the CD player in Pause and skip back to Track 8 (Example 1) again. Listen again to reconsider your answers. Skip back and listen a third time, this time writing down the correct answers. At the end of the drill set, hit pause, and score yourself.

- If you guess everything correctly, including left or right channel, give yourself 20 for the example. If you get the channel wrong but have everything else right, give yourself 15. If you guess the right family of effects but have miss the menu item, give yourself 10. Otherwise, it's the big zippo for you. A perfect score for a drill set is 100. If you guess randomly, you should probably get about 7 points. Typical scores are between 45 and 70.

After you have scored yourself, go back and check out the stuff you got wrong. Listen to the A and B version until you can easily pick out the difference.

- Skip ahead to Track 13, the beginning of Drill Set 2. Listen to the five examples, listen again to check your answers, listen a third time while looking at and writing down the correct answers, score yourself if you like, and resolve the examples you didn't get right.

  Two drill sets (ten examples) are enough for any given session.

- Work through the six drill sets on CD 1 and the 12 drill sets on CD 2 of

Hearing Amplitude

The ability to hear a signal as being louder or softer seems obvious, but given that the louder sound usually seems to sound better, it is essential to know when loudness is the ***only*** difference between two signals. That way, you neither fool yourself nor get fooled by some crazed or unethical salesperson. Another possibility I've included here is the gradual change in level. In these examples, the B version starts out identically to the A version, but gradually changes level during the example.

Hearing Distortion

You will learn to recognize THD (Total Harmonic Distortion) in recorded music, in the 10-30% range (pretty gross) and in the 1-10% range (mild). You will probably be surprised to find out that perception of distortion is significantly affected by the music being played, and also by the extent to which harmonic distortion is dependent on level. You also will learn that terms like "10% distortion" are pretty much meaningless on dynamically changing signals, and what we mean to say is something like "the loudest peaks of the recording are probably generating distortion products that are only 20 dB (10% of the amplitude) softer than the peaks themselves."

Hearing Compression

You will learn to recognize the effect of compression on a variety of different signals, and to identify fast and slow compressor release times. This is a fairly difficult area, and probably warrants significant study by itself (another future project). The "musical" impact of compression is a highly variable one, where very slight changes result in dramatically different effects.

Hearing Equalization

You will learn to recognize equalization problems, on either or both channels. This is, of course, related to the spectrum analysis drills you

Volume 2. Then, use the random function on CD 2 to really challenge yourself. Each example has its own track number. Press random and then play; listen to the A and B versions, hit pause, and check the track number on the CD player. Look up the answer. If you didn't get it right, go back over the example until you can hear it. Repeat up to ten times each session.

How These Drills Were Made

The A/B drills were created by recording an excerpt to hard disk from a commercial recording about thirty seconds long. This recording (the A version) is cloned and then passed through one of the thirty-odd signal processing possibilities we have included, and then recorded as a second hard disk sound file. This modified clone is then named "B" and assembled with the slates and "A" to create each example in the drill set. Each example uses different music.

Selection of the signal processing was done in two stages, both random. First, the family of change type was selected, including the possibility of "no change." Then, within each family, a particular change was selected. In the case where the selection involved only one of two channels, selection of Left or Right was also random. The only limit I applied was not to allow two "no changes" in a row.

I continued the practice of adding signal processing to the slates, just as a fun kind of distractor. These have no relationship to the actual examples themselves.

have been doing. For these drills we used on-console equalization rather than a graphic equalizer, and we set controls in ways that we found musically relevant. The details of the individual settings are given in the answer sheets.

Hearing the Stereo Field

You will learn to recognize anomalies in the stereo image consistently (reverse image, mono summation, polarity reversal, and pseudo-stereo). These develop your ability to identify the important and all too frequent errors that appear in our final product: the stereophonic mix. Confidence that you can reliably catch and fix these problems is invaluable.

I generated pseudo-stereo for these examples by using a 10-band graphic equalizer with alternating octaves boosted and cut and the settings of the two channels reversed. The resulting phase shift results in a "phasey" kind of stereo spaciousness.

Hearing Time Domain

You will learn to recognize channel-to-channel time differences over the 1—50 ms. range, and to recognize gated and ungated reverb.

Answer Sheet Templates for Volume 2:

Golden Ears Volume 2, CD 1 - Effects and Processing

This is the third CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying signal processing used to change a recording. The first half of the CD involves examples of 31 different possible signal-processing changes used in these examples. The remainder of the CD consists of drill sets of five examples each.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the signal processing. Keep doing this until you can hear the signal processing used.

Please note that Track Cue points occur after the identifying slates, so that you may select drills at random to test your hearing ability as it develops.

All of us at KIQ Productions gratefully acknowledge and thank the various record companies that have allowed us to use their recorded materials. We urge you to support these companies and buy their records

Credits

Created and produced by David Moulton
Engineer: Robin Coxe-Yeldham
Assistants: Bill Lee and Dan Ricci
Rights to recorded material granted by:

Boston Skyline Records, Boston, MA
SOL Records, 51 Maxfield Street, West Roxbury, MA 02131 Tel. 617-327-6470
JVC Records, Los Angeles, CA

Track 7	Time-delay/Reverb	reverb added	6
	Time-delay/Reverb	reverb deleted	9
	Time-delay/Reverb	gated reverb added	4
	Time-delay/Reverb	gated reverb deleted	9
	Time-delay/Reverb	1 ms. time delay L or R ch.	2
	Time-delay/Reverb	5 ms. time delay L or R ch.	15
	Time-delay/Reverb	15 ms. time delay L or R ch.	7
	Time-delay/Reverb	30 ms. time delay L or R ch.	8
	Time-delay/Reverb	50 ms. time delay L or R ch.	14

Drill Set 1

Track 8, Ex 1	Amplitude	3 db softer	12
Track 9, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	3
Track 10, Ex 3	Compression	compression, slow release	13
Track 11, Ex 4	Stereo	stereo reversed	14
Track 12, Ex 5	Distortion	gross (10-30%) overload distortion ("clipping")	5

Drill Set 2

Track 13, Ex 1	Stereo	one channel reversed polarity	11
Track 14, Ex 2		no change	1
Track 15, Ex 3	Equalization	L channel lows (200 Hz.) boosted & highs (10 K Hz.) cut 6 dB	7
Track 16, Ex 4	Equalization	high frequencies (10 KHz.) cut	6
Track 17, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	9

Drill Set 3

Track 18, Ex 1	Amplitude	3 dB louder	4
Track 19, Ex 2	Stereo	mono to pseudo-stereo	9
Track 20, Ex 3	Distortion	gross (10-30%) overload distortion ("clipping")	15
Track 21, Ex 4	Equalization	L channel lows boosted 6 dB @ 150 Hz.	2
Track 22, Ex 5	Equalization	mid frequencies boosted 6 dB @ 1.5 KHz.	8

Drill Set 4

Track 23, Ex 1	Equalization	R channel lows boosted 6 dB @ 100 Hz.	2
Track 24, Ex 2	Compression	compression, slow release	15
Track 25, Ex 3	Stereo	one channel reversed polarity	9
Track 26, Ex 4	Amplitude	3 dB louder	4
Track 27, Ex 5	Equalization	mid frequencies boosted 6 dB @ 1.5 KHz.	9

ANSWERS VOL TWO

CD ONE

Track 1: Introduction

Examples	Family	Specific Change	Music
Track 2	Amplitude	3 dB louder	12
	Amplitude	3 db softer	1
	Amplitude	3 dB atten during sample	11
	Amplitude	3 db boost during sample	5
Track 3	Distortion	gross (10-30%) overload distortion ("clipping")	3
	Distortion	slight (1-3%) overload distortion ("clipping")	14
Track 4	Compression	compression, fast release	13
	Compression	compression, slow release	6
Track 5	Equalization	high frequencies cut	9
	Equalization	high frequencies boosted	14
	Equalization	L or R channel lows boosted 6 dB	10
	Equalization	L or R channel lows cut 6 dB	2
	Equalization	L or R channel lows & highs cut 6 dB	4
	Equalization	mid frequencies boosted 6 dB	7
	Equalization	mid frequencies cut 6 dB	8
	Equalization	L or R channel lows boosted & highs cut 6 dB	12
	Equalization	L or R ch. mids & highs cut 6 dB	1
	Equalization	L or R channel mids boosted & opposite channel highs cut 6 dB	11
Track 6	Stereo	stereo to mono	5
	Stereo	mono to pseudo-stereo	3
	Stereo	stereo reversed	14
	Stereo	one channel reversed polarity	13

Golden Ears Volume 2, CD 2 - Effects and Processing

This is the fourth CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying signal processing used to change a recording.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the signal processing. Keep doing this until you can hear the signal processing used.

Please note that Track Cue points occur after the identifying slates, so that you may select drills at random to test your hearing ability as it develops.

All of us at KIQ Productions gratefully acknowledge and thank the various record companies that have allowed us to use their recorded materials. We urge you to support these companies and buy their records

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Drill Set 5

Track 28, Ex 1		no change	1
Track 29, Ex 2	Equalization	high frequencies cut 6 dB @ 10 KHz.	12
Track 30, Ex 3	Equalization	high frequencies boosted 6 dB @ 10 KHz.	9
Track 31, Ex 4	Stereo	one channel reversed polarity	4
Track 32, Ex 5	Compression	compression, slow release	2

Drill Set 6

Track 33, Ex 1	Amplitude	3 db boost during sample	8
Track 34, Ex 2	Time-delay/Reverb	reverb added	14
Track 35, Ex 3	Amplitude	3 db boost during sample	13
Track 36, Ex 4	Compression	compression, slow release	6
Track 37, Ex 5	Amplitude	3 db softer	7

Track 38 Calibration Data

Music Credits:

1	Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, JVC Records
2	Oscar Castro-Neves: "Brazilian Scandals", JVC 2018-2, JVC Records
3	Tom Coster: "Gotcha!!," JVC 2015-2, JVC Records
4	Frank Gambale: "Note Worker", JMID 2001, JVC Records
5	Don Grusin, "Don Grusin," JVC JMI 2010-2, JVC Records
6	Kevyn Lettau: "Simple Life," JVC 2016-2, JVC Records
7	Special EFX: "Play", JVC 2017-2, JVC Records, JVC Records
8	Sadao Watanabe, "Morning Island", JMI 2013-2, JVC Records
9	Signs of Life: "Signs of Life," SOL Records
10	Fifth Estate: "Ding Dong! The Witch is Back!", BSD 116, Boston Skyline Records
11	Seymour Hayden: "Scarlatti by Hayden", Boston Skyline Records
12	Bruno Råberg: "Pentimento," BSD 115, Boston Skyline Records
13	"The Very Best of TRACKS, 1969-1974," BSD 111, Boston Skyline Records
14	Trio Sonata, BSD 110, Boston Skyline Records
15	Trio Sonata: "Encore!", BSD 114, Boston Skyline Records

ANSWERS VOL TWO

CD TWO

Track 1: Introduction

Examples	Family	Specific Change	Music
Drill Set 1			
Track 2, Ex 1	Amplitude	3 db softer	5
Track 3, Ex 2	Equalization	R ch. lows cut 6 dB @ 200 Hz.	15
Track 4, Ex 3	Compression	compression, fast release	11
Track 5, Ex 4	Time-delay/Reverb	15 ms. time delay R channel	3
Track 6, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	7
Drill Set 2			
Track 7, Ex 1	Equalization	R ch. lows cut 6 dB @ 200 Hz.	6
Track 8, Ex 2	Distortion	gross (10-30%) overload distortion ("clipping"),	13
Track 9, Ex 3	Stereo	one channel reversed polarity	14
Track 10, Ex 4	Stereo	stereo reversed	8
Track 11, Ex 5	Time-delay/Reverb	5 ms. time delay R ch.	2
Drill Set 3			
Track 12, Ex 1	Amplitude	3 db softer	4
Track 13, Ex 2		no change	9
Track 14, Ex 3	Distortion	gross (10-30%) overload distortion ("clipping"),	12
Track 15, Ex 4	Amplitude	3 dB attenuation during sample	1
Track 16, Ex 5	Equalization	mid frequencies cut 6 dB (@ 2KHz.)	5
Drill Set 4			
Track 17, Ex 1	Amplitude	3 dB louder	15
Track 18, Ex 2	Compression	compression, fast release	11
Track 19, Ex 3		no change	3
Track 20, Ex 4	Compression	compression, slow release	7
Track 21, Ex 5	Stereo	one channel reversed polarity	6

Drill Set 5			
Track 22, Ex 1	Stereo	mono to pseudo-stereo	13
Track 23, Ex 2	Compression	compression, fast release	14
Track 24, Ex 3	Equalization	L ch. lows (200 Hz.) boosted & highs (8 KHz.) cut 6 dB	8
Track 25, Ex 4	Time-delay/Reverb	gated reverb added	2
Track 26, Ex 5	Equalization	L ch. lows boosted 6 dB @ 200 Hz.	4
Drill Set 6			
Track 27, Ex 1	Distortion	gross (10-30%) overload distortion ("clipping"),	9
Track 28, Ex 2		no change	12
Track 29, Ex 3	Stereo	stereo to mono	1
Track 30, Ex 4	Amplitude	3 dB louder	5
Track 31, Ex 5	Time-delay/Reverb	reverb added	15
Drill Set 7			
Track 32, Ex 1	Amplitude	3 dB louder	3
Track 33, Ex 2		no change	11
Track 34, Ex 3	Equalization	mid frequencies cut 6 dB @ 1 KHz.	7
Track 35, Ex 4	Compression	compression, fast release	6
Track 36, Ex 5	Amplitude	3 db softer	13
Drill Set 8			
Track 37, Ex 1	Amplitude	3 db boost during sample	14
Track 38, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	8
Track 39, Ex 3	Time-delay/Reverb	15 ms. time delay R ch.	2
Track 40, Ex 4	Stereo	stereo reversed	4
Track 41, Ex 5	Compression	compression, slow release	9
Drill Set 9			
Track 42, Ex 1	Distortion	gross (10-30%) overload distortion ("clipping"),	12
Track 43, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	1
Track 44, Ex 3	Stereo	stereo to mono	5
Track 45, Ex 4	Equalization	L ch. mids (1K) boosted & R ch. highs (10K) cut 6 dB	15
Track 46, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	5
Drill Set 10			
Track 47, Ex 1	Amplitude	3 dB louder	11

Problems, Suggestions and Comments

Over the years there have been several routine comments that students have made about the drills that I would like to discuss in order to ease your mind.

1. "The equalization drills can be tough to hear, especially octaves 1 and 10."

The equalization drills involve all ten octaves of the audio spectrum. Because the examples are chosen at random, the octave centered at 31 Hertz is often involved. What you will soon discover is that most loudspeakers don't do much below 40 Hertz and most recorded music doesn't have much energy down there either. So, such examples are hard (impossible, sometimes) to hear. In keeping with the realities of the real world, that's life. Remember to guess!

2. "The slates are really annoying."

Comments (including some remarkably rude ones), suggest that my slates are a distraction, particularly with the A/B drills. There is a reason: auditory memory fades quickly, and the drills become much easier (too much so, in fact) if the transition from A to B is very quick. Again, real life doesn't work that way: the problems usually occur *while* two people are talking to you *while* you eat a hamburger in the doorway of the studio *while* an automated mix is being made. ***That's*** when you need to be able to hear the aforementioned reverb return drop out. So, the slate is intended to serve as a buffer, a distractor, between the two examples.

3. "It's really hard to hear the stereo examples!"

Many of the A/B drills that involve stereo/mono, polarity reversal, change on one channel only, etc. are mainly audible along the median plane and barely audible anywhere else in the room. This is an important lesson to learn. If you sit off to the side of the median plane, you are going to be in trouble.

Track 48, Ex 2	Equalization	R ch. lows boosted 6 dB @ 200 Hz.	7
Track 49, Ex 3	Distortion	slight (1-3%) overload distortion ("clipping")	6
Track 50, Ex 4	Amplitude	3 dB louder	13
Track 51, Ex 5	Amplitude	3 db boost during sample	14

Drill Set 11

Track 52, Ex 1	Equalization	high frequencies cut 6 dB @ 8 KHz.	8
Track 53, Ex 2	Time-delay/Reverb	15 ms. time delay L ch.	2
Track 54, Ex 3	Equalization	mid frequencies cut 6 dB @ 2 KHz.	4
Track 55, Ex 4	Equalization	R ch. lows boosted 6 dB @ 100 Hz.	9
Track 56, Ex 5	Stereo	stereo reversed	12

Drill Set 12

Track 57, Ex 1		no change	1
Track 58, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	5
Track 59, Ex 3	Stereo	mono to pseudo-stereo	3
Track 60, Ex 4	Time-delay/Reverb	50 ms. time delay R ch.	7
Track 61, Ex 5	Amplitude	3 dB attenuation during sample	6

Track 62 Calibration Data

Music Credits:

1. Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, JVC Records
2. Oscar Castro-Neves: "Brazilian Scandals", JVC 2018-2, JVC Records
3. Tom Coster: "Gotcha!!," JVC 2015-2, JVC Records
4. Frank Gambale: "Note Worker", JMID 2001, JVC Records
5. Don Grusin, "Don Grusin," JVC JMI 2010-2, JVC Records
6. Kevyn Lettau: "Simple Life," JVC 2016-2, JVC Records
7. Special EFX: "Play", JVC 2017-2, JVC Records, JVC Records
8. Sadao Watanabe, "Morning Island", JMI 2013-2, JVC Records
9. Signs of Life: "Signs of Life," SOL Records
10. Fifth Estate: "Ding Dong! The Witch is Back!", BSD 116, Boston Skyline Records
11. Seymour Hayden: "Scarlatti by Hayden", Boston Skyline Records
12. Bruno Råberg: "Pentimento," BSD 115, Boston Skyline Records
13. "The Very Best of TRACKS, 1969-1974," BSD 111, Boston Skyline Records
14. Trio Sonata, BSD 110, Boston Skyline Records
15. Trio Sonata: "Encore!", BSD 114, Boston Skyline Records

The median plane (as taught in high school geometry—it had to come in handy sometime) consists of all points equidistant from each speaker. Anything more than a couple of inches off the median plane will do grievous damage to the stereo illusion, particularly for critical listening and stereo audio mixing.

As an audio pro, learn to fight for a seat on the median plane: your career may depend it!

4. "What is The Secret to acing these drills in nothing flat?"

Frankly, I think intuitive guessing (snap off the answer quickly, without thought, as soon as you hear the stimulus) works pretty well, particularly as you gain experience. When pink noise is the signal source, characterizing the octave bands (2 kHz. as a leaky steam fitting, 63 Hz. as a distant jet engine, for instance) works pretty well. However, this labeling technique has its dangers when you get into program material, because your pet noise characterizations may not align with the instrumental timbres you are listening to. Over the long run, I personally have tried to memorize a sense of "highness" or "lowness" for each octave band, and found this works quite well in real life. If you have a sense of the "sound" of an octave band (and the sound of its absence) firmly fixed in your ear-memory, it is quick work to move into the equalization realm to fix problems during recording sessions.

For the A/B drills, I think you have to hang loose, and let the answers come to you. (How's that for pseudo-Zen?) You do this by relaxing, letting yourself notice that there is a difference, and then intuitively guessing what the difference is (the most terrifying thing about these drills is that often you can't hear a difference at first). Sure, you'll be wrong a lot, but the trick is to *notice that there is a difference.* Once you can do that, the rest is fairly easy. Remember, there is no way that you can *learn and know* all the differences in your mind beforehand by brute intellectual force.

The drills all involve self-scoring, if you care to indulge. Keep in mind that

this is not a competition, and just because you score in the high 90's doesn't mean that you have better hearing than some other poor schlumpf. What it means is that you are more effectively recognizing and articulating what you are hearing than you were when you were scoring in the low 80's. So, the drills aren't tests, and the strictly optional scoring is for your own information and critical evaluation.

History of These Drills

I started giving these ear training drills to individual students and small classes in my own recording studio in the early 1970s. The method is based on traditional musical ear training methods that were inflicted on me in music school (Juilliard), but with as much of the terror removed as possible. (Some music schools used to treat ear training as a rite of passage, an initiation-by-humiliation ritual.)

As some of you may know, in traditional music ear-training, students practice hearing and identifying intervals, chords, melodies, rhythms and counterpoint. "Taking dictation" (Gulp!— I still cringe in fear, just thinking about it!) meant listening to the teacher play something and writing it down by ear. The beginning part of this training was simply identifying intervals and chords. It is from that basic practice that I developed these drills. I've found that the terror part of ear-training is not only unnecessary, but actually counterproductive, and that by being friendly and supportive about it my students (that's you, now) progress quickly and enthusiastically.

So, when you do the drills in Volume 1 you will be doing the equivalent of identifying intervals and chords: you will be learning to identify regions of the audio spectrum. Volume 2 includes drills to help you learn to discern signal-processing (I call them A/B drills), and after that there will be increasingly challenging spectrum drills, to a point where you should be able to hear and identify complete equalization settings by ear. That's right, you should be able to listen to an equalizer switched in and out on a recording and describe how the equalizer is set, in terms of frequencies and the amount of boost or cut, by ear alone!

These drills have evolved somewhat over the years, and have achieved a certain amount of renown. National Public Radio has used them as part of the training for their production and engineering personnel, and I have used them in a variety of college programs, including the Music Production and Engineering program at Berklee and the Tonmeister Studies program at the State University of New York, College at Fredonia. In addition, they have been used by faculty at UCLA, New York University, the Danish Acoustical Institute, and NBC. At present, I am developing a full course in critical listening based on these drills for Emerson College in Boston.

There are other people also working on critical listening skills for music and audio. Alton Everest and Tom Rossing have released some excellent auditory demonstration recordings. Their recordings are intended to demonstrate the audible effect of various signal processing operations and psychoacoustic effects. Andresj Miskiewicz, currently at Northeastern University in Boston and formerly at the Chopin Academy in Warsaw, Poland, has developed a wonderful and very powerful curriculum that he calls *Auditory Solfege*. This is an active ear-training curriculum (you need a teacher and a fair amount of hardware to do it) for recording engineers that involves an elaborate array of exercises and training. After three years of study, you can hear and identify just about everything! Will Moylan, at the University of Massachusetts at Lowell, has developed an auditory skills course that involves analytical listening and notation of recorded sounds that is generally related to the "taking dictation" part of conventional music ear-training. Check out his book, *The Art of Recording: The Creative Resources of Music Production and Audio.*

My drills are a series of exercises intended to help you learn how to identify sound characteristics under a wide variety of circumstances, by ear alone. Through practice on drills of increasing levels of difficulty, they allow you to develop hearing skills and the ability to describe sounds to a point fairly close to the limits of auditory discrimination for frequency and amplitude. They are designed for home use, and to be extremely user-friendly. All you really need is a CD player and moder-

ately decent speakers or headphones. After you've gone through and mastered the drills in Volumes 1 and 2, you should be able to describe the response curve of any given system, as well as the control settings on an equalizer, the amount of delay on a time-delay line, and the settings on a compressor or noise gate. Further, you should be able to pick out most regular signal processing with considerable confidence.

This audio ear-training can be fun, in a weird kind of way. You will find that it can easily arouse your competitive instincts, and you may come to delight in impressing your friends at parties with your new-found high-tech vocabulary, as in, "The zither seems to be down two dB at 750 Hz. and there's about 4% Total Harmonic Distortion on the second harmony bagpipe track. Oh, and by the way, the mid-range driver on the left speaker is wired out of polarity." However, audio ear training is much more than a game. You really cannot expect to make professional quality music without such skills. Intelligent hearing (AKA Golden Ears) is a basic tool you should have in your bag of audio goodies (next to the red Sharpie, the Etymotic Ear Plugs and the Tylenol).

Objectives of this study

The Ear as an Acoustical Test Measurement Instrument

The human auditory system is a remarkable sensory system, capable of observations and discrimination that equal or exceed all but the most elaborate testing equipment we've been able to build to measure sound. Therefore, it is possible for us to use our hearing as a test instrument, once we figure out how to articulate what it is we are hearing. The ability to accurately describe the physical nature of what we are hearing is a primary objective of the Golden Ears Drills.

Ear Training and Learning

There is also a higher-level "Zen of learning" aspect to all ear-training. Musical sound is generally perceived in the right hemisphere of the

brain as "spatial" or holistic patterns, and as such is not generally available to the "verbal" left brain for conscious verbalized description. This is part of the difficulty with ear-training. Although the actual act of perception is fairly easy, it exists in a realm of our consciousness that doesn't have words.

(If you are curious about this right brain/left brain business, check out Tom Blakeslee's excellent book for normal people, *The Right Brain.*)

Nonetheless, you can certainly learn to describe what you hear, and the ability to effectively articulate audio issues is priceless in our field. The clumsy, inarticulate conversation that takes place among musicians, engineers, and producers, such as "Can you like, make, the guitar a little fluffier, y'know what I mean?" seriously interferes with their creative efforts.

Being Able to Speak Accurately About What You Hear

As you become fluent at this, you will be able to easily note many things about a recording, quickly and apparently effortlessly. You will be able to "hear through" the recording much better, identifying signal processing, level problems, etc. with little trouble.

How Good Can Your Ears Get?

A couple of years ago, a colleague of mine, who likes to complain that he is going deaf in one ear and can't hear anything high in the other, knocked the proposed CBS Copycode scheme (which was allegedly inaudible) right out of the ballpark by identifying it 100% of the time in controlled double-blind tests conducted by the National Bureau of Standards. Once he astounded me by identifying, by brand and model, the side microphone I had used in a middle-side stereo recording I was playing for him, and noting (correctly, as I found out to my chagrin) that it was not functioning to spec! And yes, he has done these drills!

When you get the hang of doing these drills, the stuff you can hear will

seem equally magical to others, and your ability to quickly and surely arrive at the sound you need will seem remarkable to them. To you, it will be obvious and intuitive. You will have Golden Ears.

A Few Warnings

The Challenge

Try not to lose self-confidence when working on your Golden Ears. It can be a slow process of learning, and you may occasionally get stuck and feel like you aren't progressing. Stick to it and pace yourself. Just as when you learned to ride a bicycle, you learn this stuff through repeated failures.

Also, I think it is really important to go over this stuff *with the answers in hand* repeatedly until you are sure you actually can consciously identify the sounds we are studying. You will often get lost, will not be able to hear a change, or will hear something else (a boost in EQ will of course make something louder— the trick is to know that it wasn't just louder, but louder at a specific part of the spectrum). You will get frustrated and tired sometimes. Keep the faith! It's like learning to ride a bicycle!

Getting Lower Scores While You Are Getting Better

The nature of the drills is such that as you progress, the drills get harder. If you bother to score yourself, you may notice that your scores keep getting worse. Don't be discouraged. To use a golf analogy, the drills start out as all Par 3 and progress to being all Par 6! Don't expect to be getting Par 3 scores on Par 6 exercises!

If you need a quick ego boost as you get mired down in some of the more advanced stuff, go back and try the earlier, easier drills. For instance, after you've been trying to guess that B has attenuated 3 dB during the exmple, you will find that pink noise boosted 12 dB in one octave band is *really disgustingly easy.*

About Monitors

There is no such thing as a perfect monitoring environment. Because these exercises utilize the *entire audible spectrum*, weaknesses in your monitoring system will be exposed. This is exacerbated by the fact that you are performing extremely critical listening. The solution here is to simply ***do*** your ear training, accepting and compensating in your mind for the apparent frequency response deficiencies introduced by your monitors. In fact, the audio recordings you produce or listen to will be played on countless different systems, many of which are probably inferior to your monitoring set-up. Learning to compensate mentally for deficiencies in the monitoring space is part of training your Golden Ears.

Changing Ears

As you start this drill work, you will notice that your perception of sounds changes. For a while, it may be a little disconcerting, and you should be mentally prepared for this. As you begin to internalize the audible spectrum, you will start hearing everything in terms of octaves. You roll down the car window at seventy (er, fifty-five, I know, I know) and hear Octave 2 (63 Hz.) instead of wind buffeting. You tune in a sports event and instead of crowd roar you hear Octave 5 (500 Hz.). Instead of a light metallic edge on an acoustic guitar you hear Octave 9 (8 kHz.)!

Also, the A/B drills will make you so paranoid about each little nuance that you will start listening to just the spaces *between* the sounds. For a while, you will find you stop hearing the music and instead hear only the reverb, the sonic detailing, the delays, the release trails and attack pumping of compressors. Whew!

This goes away, sort of, after you have acquired and internalized these Golden Ear skills, so that your original musical focus and subjective enjoyment comes back. But you will also have an added dimension, a hearing acuity that allows you to hear your way into and through the

sounds in a way that you never could before, forever altering your sense of what sound is and can be.

Tarnished Ears?

Do not panic if you find you can not hear above 19,995 Hz. Lots of students have come to me in terror because they can't hear some high frequency and are sure their carcer is over! In fact, the half-octave bout 15 kHz. isn't terribly significant musically and isn't played back by all that many audio systems.

We often refer to the audible spectrum as 20 Hz. to 20 kHz., but those stated limits are really just convenient values for us to remember. A more functional definition of the useful audible spectrum for music recording might be 40 Hz. to 15 kHz. In addition, the fact that you are in the audio engineering field at all suggests you have had above average exposure to sound at loud levels (in the studio, attending/working concerts, etc.). So it is possible that you may even have slightly reduced acuity at some frequencies. Additionally, we aren't all born equal. Women, in my experience, seem to have greater sensitivity to high frequencies and to harmonic distortion than men. Individual variances between people are significant as well. Don't worry! Knowing more specifics about what you can and cannot hear will improve your critical listening skills. You can be sure that many of the engineers whose work has sold millions of records have done it with hearing that is physiologically far from perfect. The colleague I mentioned above is a classic example.

Tired Ears

Ah, yes. Tired ears are also tired brains. And when you are tired, you can't hear very well, in a critical listening sense. You can't do these drills for very long, just as you can't expect to work totally creatively and productively for sixteen hours at a stretch. The perceptual job is just too tough, and you've got to accept the limitations of your own particular attention span.

How do you know when you are tired? When louds don't seem loud anymore, and you feel the urge to ***really crank it up*** to give you a little shot of adrenalin. We all like to crank it up, of course, but I suggest that you limit it to the occasional recreational abuse, at home. Don't do it as a professional practice.

Another sign that you're getting tired is when you begin to get confused, bored, or impatient, which is nature's way of telling you it's time to stop. Work on this stuff only for as long as you can really *focus* on it.

In Closing...

As your experience develops, your confidence in recording, mixing, production, and listening sessions will go way up. That's because you can not only hear, but also describe what you hear in physical quantities, saying "the toms are boosted 6 dB at 250 Hertz" instead of "the toms sound tubby," or "the piccolo is down 3 dB at 500 Hertz," instead of "I think the piccolo sounds thin"

This business is really about sound, and this is the best doorway into sound that I know. So don't let the Audio Devils get you. May the Force be with you, and remember, if you can't hear it, it's probably 31 Hertz being cut! Good luck!

Dave Moulton
Groton, MA

PS: We'd really like to hear from you about these drills. We're open to suggestions, improvements, etc., and would just like to talk to anybody that has bothered to read this far! So, please write or call if you have questions, comments, complaints, or suggestions.

As you know, we have more drills on the drawing boards. Is there anything in particular you would like? We are also looking at CD-ROM and CD-I. Any thoughts?

Thanks again for your interest.

Just write to:

KIQ/Golden Ears, 13351-D Riverside Drive,
Sherman Oaks, CA 91423

or call us at 818-905-5432

Acknowledgments

I'd like to thank a bunch of people for their support. In the beginning, at Dondisound Studios, Greg Becker and Tom Swift gave me a tremendous amount of help. Too many wonderful students to mention by name at SUNY/Fredonia suffered through early versions and gave me much help and guidance (it used to be a weekly ritual— ear training at 6 PM every Monday for the Tonmeister students). At National Public Radio, Skip Pizzi, Neil Muncy, Paul Blakemore, Curt Wittig, Elaine Salazar, Dave Glasser, and Terry Skelton all provided great help and support. At Berklee, I'd like to specially thank Tony Dibartolo, Mark Wolinski, Mark Hutchins, Robin Coxe-Yeldham, Wayne Wadhams, Carl Beatty, and Mitch Benoff, not to mention Alex Hodge and Peter Alhadeff. At Home and Studio Recording Magazine, thanks to Nick Batzdorf for encouraging me to go ahead with this project. And especially, thanks to my wife June, who used to do these drills on the sly out in the office while I was doing classes in the control room at Dondisound, and who has listened to more pink noise than anyone should ever reasonably have to! Thanks again to all of you!!

GOLDEN EARS

About the author

Dave Moulton has degrees in music from Bard College and the Juilliard School of Music. He has taught music, audio, and acoustics at a variety of colleges, including the State University of New York, College at Fredonia and Berklee College of Music, where he has served as Chair of the Music Production and Engineering Department. He is currently on the faculty at both the University of Massachusetts at Lowell and Emerson College in Boston. During the 1970s he owned and operated Dondisound Studios, a commercial recording facility in upstate New York. He has been active in acoustics and loudspeaker design and shares in several patents pertaining to loudspeakers. He is currently a writer for *Home and Studio Recording Magazine*, and is completing a book on music recording. Dave is active as a composer and recording engineer.

Golden Ears Volume 1 Ear Training Drill Answer Sheets

Drill: Boost or Cut Pink Noise or Music 12 dB

Instructions: After a warmup demo, you will hear 10 examples of Pink Noise or Music being boosted or cut in 1-octave bands by 12 dB. You guess which octave is being boosted or cut. Answer in the row labeled "Your answer."

Enter the correct answer in the next row. Score according to instructions. Add your scores up for Total.

Be sure to indicate whether each example is boosted or cut, as well as which octave is involved.

The following five pages are templates—feel free to Xerox them at will.

Answer sheet template — Volume One, Frequencies

Reference guide to octaves and frequencies

Octave	1	2	3	4	5	6	7	8	9	10
Ctr. Freq.	32	63	125	250	500	1000	2000	4000	8000	16000
Range	20-40	40-80	80-160	160-320	320-640	640-1.25K	1.25-2.5K	2.5-5K	5-10K	10-20K

Drill Set# _____

Example#	1	2	3	4	5	6	7	8	9	10	
Your answer:											
Correct answer:											
Score:											Total score:

Drill Set# _____

Example#	1	2	3	4	5	6	7	8	9	10	
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Drill Set# _____

Example#	1	2	3	4	5	6	7	8	9	10	
Your answer:											
Correct answer:											Total score:
Score:											

Score 10 points for each correct family
Score 10 points for each correct identification of A/B difference
Take 5 points off for guessing the wrong channel

FAMILY	ACTUAL A/B CHANGE
Amplitude	3 dB louder
Amplitude	3 db softer
Amplitude	3 dB attenuation during sample
Amplitude	3 db boost during sample
Distortion	gross (10-30%) overload dist.
Distortion	slight (1-3%) overload distortion
Compression	compression, fast release
Compression	compression, slow release
Time-delay/Reverb	reverb added
Time-delay/Reverb	reverb deleted
Time-delay/Reverb	gated reverb added
Time-delay/Reverb	gated reverb deleted
Time-delay/Reverb	1 ms. time delay L or R ch.
Time-delay/Reverb	5 ms. time delay L or R ch.
Time-delay/Reverb	15 ms. time delay L or R ch.
Time-delay/Reverb	30 ms. time delay L or R ch.
Time-delay/Reverb	50 ms. time delay L or R ch.
Equalization	high frequencies cut
Equalization	high frequencies boosted
Equalization	L or R channel lows boosted 6 dB
Equalization	L or R channel lows cut 6 dB
Equalization	L or R channel lows & highs cut 6 dB
Equalization	mid frequencies boosted 6 dB
Equalization	mid frequencies cut 6 dB
Equalization	L or R channel lows boosted & highs cut 6 dB
Equalization	L or R ch. mids & highs cut 6 dB
Equalization	L or R channel mids boosted & opposite channel highs cut 6 dB
Stereo	stereo to mono
Stereo	mono to pseudo-stereo
Stereo	stereo reversed
Stereo	one channel reversed polarity
	no change

Golden Ears Audio Ear Training Drill Answer Sheet: A/B Drills

*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
				Total score:	

*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
				Total score:	

*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
				Total score:	

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*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
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Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
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*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
				Total score:	

*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
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Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
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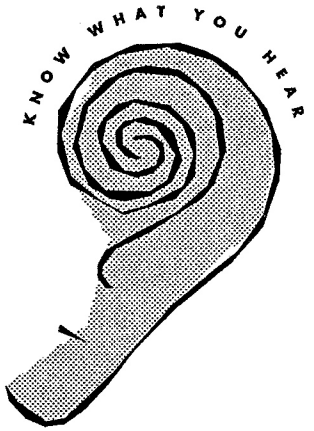

GOLDEN EARS

ANOTHER KIQ PRODUCTION

Instruction Manual

BY DAVID MOULTON
assisted by Alex Hodge and Peter Alhadeff

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The performance baseline for audio technology has improved dramatically over the past twenty years. From the recording studio to the listener's loudspeakers, we have come to expect recordings of superb acoustic instruments, really convincing sampling and synthesis, mega-awesome processing capabilities, and so forth. We now expect audio quality that includes flat frequency response, noiseless and distortionless audio signals, and superb time and spatial resolution. To get these things, we need extremely well-developed critical listening skills.

Golden ears are skilled enough to discern, measure, analyze, and express the physical qualities of musical sounds accurately. Once you have them, you will be able to listen to recordings with more sensitivity and awareness, as well as a lot more enjoyment. This is particularly true when you are engineering or producing music and have to make critical decisions about it.

Golden ears enable us to realize the full potential of our audio systems in the production of recorded music. This CD set provides a crucial tool for developing those ears quickly and easily. It provides a base of auditory experience and knowledge that is essential for working with modern recorded music. Working through these drills and using them as refreshers from time to time will permit you to gain and maintain the equivalent of five to ten years of critical listening experience in a matter of weeks.

As you get good at these drills, you will be able to pinpoint problems rapidly and make useful decisions about how to deal with various audio and musical problems, instead of having to resort to the more traditional "keep turning knobs until something sounds good" approach, with its accompanying hype ("I'm just resetting the critical phase offsets. I'll be with you in a second. There, how's that? Ya gotta love it!"). You will come to know, by ear, how the audio energy is distributed across the spectrum, approximately how loud two sounds are relative to each other, the kinds of signal processing going on, and so on. Almost as important, you will be able to easily detect when others are reduced to random knob-twiddling and hype.

Dave Moulton

INTRODUCTION

Welcome to the Golden Ears audio eartraining program. This manual and the accompanying CDs are the product of close to two decades of studio experience as well as teaching recording engineering and production at a number of institutions. The volume(s) you have purchased, Volume 1: Frequencies, and/or Volume 2: Effects and Processing, are the cornerstones of an anticipated series of audio eartraining drill sets. Each volume is an independent course, designed to condense years of hands-on experience into a matter of weeks.

As you work your way through the exercises, you'll find yourself hearing recordings in a completely new light. Furthermore, you may expect these CDs to provide years of service as a reference. Long after mastering the exercises, you'll be able to give your ears an occasional "workout" to maintain your valuable skills.

About this manual: Many people have an aversion to reading manuals. However, if you want to start right in with the CDs, go ahead. Simply put on the first CD, play it, and try to figure it out. When you get confused or bored, or just feel like reading something, that's when you should read the manual.

On the other hand, the manual and the CDs are designed to work together. We haven't wasted valuable CD recording time with information that could be better presented in this manual. I've tried to put as much useful material as possible in this manual, so you might want restrain your initial urge to leap right in.

Pages have been printed on the right side only to leave space for notes; you can either go straight to the drills or read this manual in its entirety first.

Why develop Golden Ears? The auditory challenges facing today's musicians and recording, mixing, and mastering engineers are really substantial.

the nominal level), and represents the maximum level that your playback system will ever need to handle for these drills. You should simply confirm that the system doesn't show signs of distress (bad odors, crackling noises, obvious distortion, etc.) at this level. If it does, you will need to turn down the playback level until it can be reproduced with ease by your system.

Checking the Response of Your System Using the Tones.

The last track on the CD is about 20 seconds long and consists of five sinusoidal tones, in the following order:

1 KHz., 10 KHz., 100 Hz., 15 KHz., 40 Hz.

These are at the nominal listening level. Each tone goes on for about five seconds.

You should play back the five tones. If you can't hear 1 KHz., 10 KHz. or 100 Hz. at the nominal listening level, there is a serious problem with your monitoring system that has to be dealt with before you can proceed. The loudnesses of these tones may sound different to you— so long as the differences are not extreme, you are OK. The 15 KHz. and 40 Hz. tones represent extremes of the audio spectrum, both for the equipment and for our hearing. Expect them to be significantly softer in level. They may even be inaudible or barely audible. If so, you can proceed, but you should be aware that you may have a little trouble hearing the extremes of the spectrum.

You are now ready to begin the drills.

There are two basic types of drills: sets of examples of changes in loudness of octave bands of the audio spectrum and critical (A/B) comparisons of two versions of a recording.

USING THE CDS

Doing the exercises

Calibrating the system

Calibration consists of a brief sequence of pink noise and five tones. The pink noise will be used for setting playback level, and the tones will be used to confirm the spectrum range of your playback system. The calibration material is at the ***end*** of each CD. This way you don't have to listen to it each time you start up.

First, you will set your playback level. It is fairly important ***not*** to adjust levels while you are doing the drills (because of the variation in level vs. spectrum at different loudness levels— the so-called Fletcher-Munson curves). You will listen to the pink noise to do this.

Then you will check out the spectrum using the tones. You should probably have all of your tone controls off or set at flat, unless you are *really* attached to some listening setting that you like an awful lot. Also, if you have a loudness compensation button on your playback preamp or receiver, you should turn it off.

Setting Playback Level Using Pink Noise

The pink noise is played at three different levels. The first level is the "nominal listening level." It will be at the same loudness as the slates and drills when nothing is boosted or cut. You should set the your playback level so it is comfortably medium loud, subject to the considerations of the next two pink noise levels (75 dB SPL might be nice, if you have an SPL meter handy). The second level is 6 dB louder than the nominal listening level and it is about as loud as any of the drills ever get. You should verify that (a) it doesn't cause your speakers or the neighbors any distress and (b) it is comfortable, if somewhat loud. The third level is another 6 dB louder (12 dB above

The Equalization Drills

The equalization drill sets each consist of ten examples. Each example is about ten seconds long and consists of either pink noise or music. The example begins with the sound played normally. After about three seconds, the sound is altered by boosting or cutting the amplitude of one or more octaves in the spectrum, using a graphic equalizer. After about four seconds of equalized sound, the sound is returned to its normal state. Your task is to identify which octaves of the spectrum were boosted or cut.

To help you, there is a warmup drill preceding the drill set to let you get the "sound" of the various octaves "in your ears." Also, the beginning drill sets restrict the octave ranges being changed into groups called "low" (octaves one through five, 31—500 Hertz), "mid" (octaves four through eight, 250—4000 Hertz), and "high" (octaves six through ten, 1 KHz.—16 KHz.). This greatly simplifies your decision-making at the beginning.

Doing the Equalization Drills

Calibrate your system (refer to the previous section) and get yourself set on the median plane (equidistant from each speaker). You will find the answers to these exercises at the end of this chapter and answer sheet templates at the end of the manual. Start at the beginning, with Drill Set 1 of the first CD of Volume 1.

- Play the Drill Set, which will include the warmup drill. While listening to the warmup drill, try to memorize the sound of the octaves being boosted. Then listen to the ten examples of the drill set. Guess which octave is being boosted and write it down, expressing it as a center frequency (i.e. "125 Hz.").

When you complete the drill set, hit pause on the CD player, and skip back to the beginning of the drill set. The CD will cue up just after the slate for the drill set itself, at Example 1.

Frequencies

- Play the drill set a second time to double check your answers. Pause and skip back again. Now take out the answer sheet that is included in the CD booklet, and play back the drill set a third time, listening while writing down the correct answers on the answer sheet.

- Pause again at the end to score yourself. If you guess the correct octave on an example, give yourself 10 for that example. For each octave "off" you are, take away 1, so that if you guessed 1 KHz. (Octave 6) and the right answer was 250 Hz. (Octave 4), your score is 8. Total up your scores for all ten examples. A perfect score for a drill set is 100. If you simply wrote down random answers, you should get around 40 points. What I've found is that scores of between 85 and 95 are typical for single octave bands of music being boosted or cut, once you get the hang of it.

- Now go ahead to Drill Set 2. Once again, listen to the warmup drill and play through the ten examples while guessing which octave is boosted. Listen to the examples a second time to reconsider your answers. Then play back the examples while looking at the correct answers and entering them on the answer sheet. Pause and score yourself.

- Go ahead to Drill Set 3 and repeat.

- Quit for the time being. It is counterproductive to work on these exercises when your ears are tired.

- Start your second session by repeating the last drill set of the previous session. Again, do three drill sets, listening to each drill set twice before checking the answers. Always ***listen*** to the drill set while you check the correct answers, and write those correct answers down to help you learn to "visualize" in your mind the correct answer related to the sound.

Work through both CDs in Volume 1 this way, repeating the last drill set from the previous session and adding two new drill sets.

Drill Sets 1-3 involve pink noise being boosted in low, middle and high

regions of the audio spectrum.

Drill Sets 4-6 use musical material instead of pink noise, again boosting in low, middle and high regions of the spectrum.

Drill Set 7 will introduce cuts, again starting with pink noise. You will probably find it is easiest to identify the frequency of the octave being cut when it is being brought back in at the end of the example.

Drill Set 13 begins to deal with the entire spectrum, so that your range of possible choices is much larger. If you find yourself getting confused by too many choices, feel free to go back and review any of the first 12 drill sets in order to get your bearings.

Drill Set 5 on the second CD introduces the possibility that a given octave is ***either*** boosted ***or*** cut. As you do these drills, you must indicate on the answer sheet whether the octave in question is boosted (use a "+") or cut (use a "-"). When you score this or later drill sets where you have to guess whether the octave is boosted or cut, if you guess wrong, take away two more points, so that if you had guessed 1 KHz. boosted when in fact 250 Hz. was cut, your score would be 6.

- When you have worked your way through both CDs of Volume 1 this way, you should then try CD 1 on random play. Now you will do the drill sets without a warmup and without knowing what the drill set is going to be about. ***Always*** listen again while writing down the correct answers.

- When you have become proficient at hearing the drills on CD 1, switch to CD 2 and play it randomly. To provide a little more challenge, try listening only once to the drill set before checking with the correct answers. CD 2 can be played lots of times (probably close to an infinite number— although why you would do that I honestly do not know) before you will know it well enough to be able to remember the answers.

VOLUME ONE

Hearing the Audio Spectrum

Through all of this, limit your sessions to three or, at the most, four drill sets.

How these drills were made

The equalization drills were produced using Pink Noise from an Ivie Pink Noise generator and Compact Disc recordings in a variety of musical styles. Although these drills are pretty close to Fair Use under the copyright law, we have obtained permissions from all owners of the recorded material, and would like to thank them by encouraging you to support them by buying their records. See the credit list for a complete listing of all recordings used.

Both the Pink Noise (in mono) and the recordings (in stereo) were passed through a UREI 10-band graphic equalizer and then recorded directly to hard disk via Digidesign's Pro Tools for editing and assembly. The graphic equalizer was set flat and for each exercise the appropriate octave band was boosted or cut by the appropriate amount (12 dB, or the limit of travel, for Volume 1). In the music recordings, both channels were treated identically.

I determined which band(s) to boost or cut by the use of a random number generator, subject to the following limits: I never did the same thing twice in a row, and I ***excluded*** "no change" as a possible answer. Because the selection was random, don't expect that all octave bands must be included in any drill set, or that you can *anticipate* what we are going to do next. I wasn't trying to fool you or play mind games.

After assembly editing of all the drills and slates, I got bored with the slates and decided to add signal processing to an occasional slate, for amusement. The processing varies from slate to slate and it's there to give you something else to do while improving your mind.

The slate for each track actually appears at the ***end*** of the warmup drill, so that you may listen 'blind' to each track.

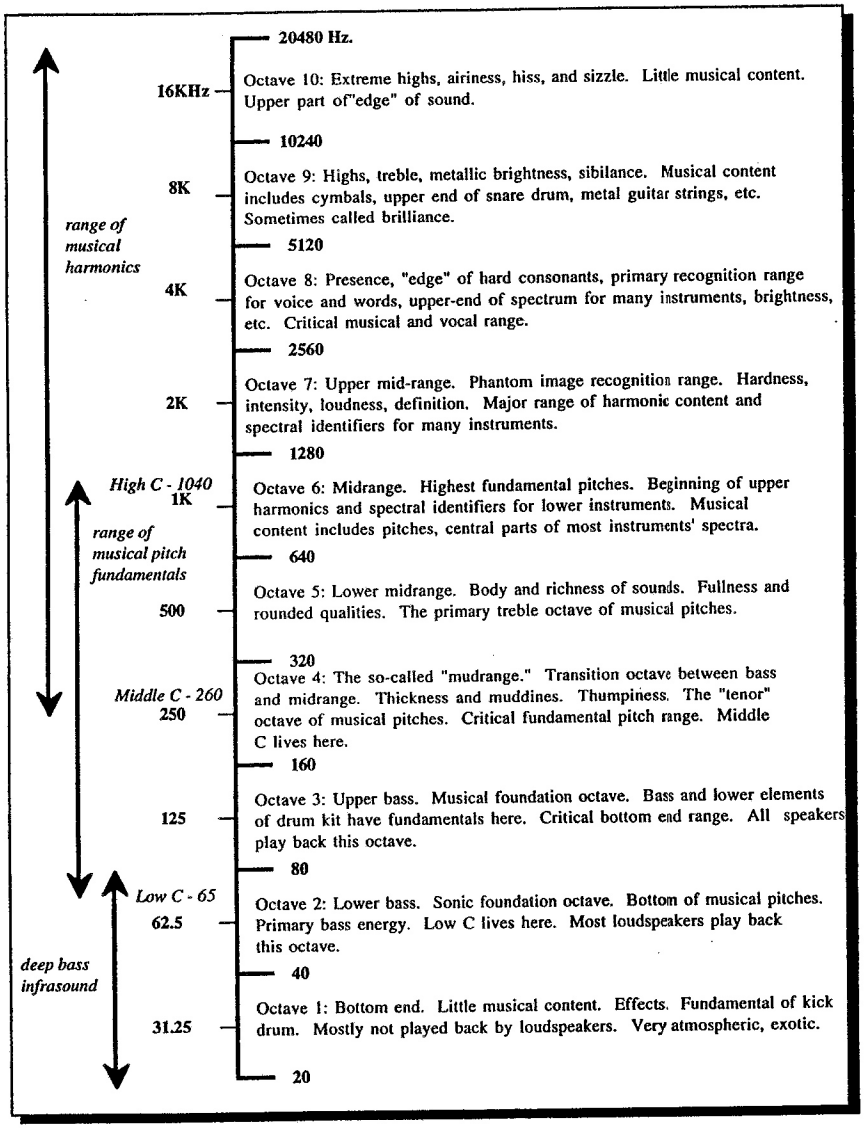
20480 Hz.
16KHz
Octave 10: Extreme highs, airiness, hiss, and sizzle. Little musical content. Upper part of"edge" of sound.
10240
8K
Octave 9: Highs, treble, metallic brightness, sibilance. Musical content includes cymbals, upper end of snare drum, metal guitar strings, etc. Sometimes called brilliance.
range of musical harmonics
5120
4K
Octave 8: Presence, "edge" of hard consonants, primary recognition range for voice and words, upper-end of spectrum for many instruments, brightness, etc. Critical musical and vocal range.
2560
2K
Octave 7: Upper mid-range. Phantom image recognition range. Hardness, intensity, loudness, definition. Major range of harmonic content and spectral identifiers for many instruments.
1280
High C - 1040
1K
Octave 6: Midrange. Highest fundamental pitches. Beginning of upper harmonics and spectral identifiers for lower instruments. Musical content includes pitches, central parts of most instruments' spectra.
range of musical pitch fundamentals
640
500
Octave 5: Lower midrange. Body and richness of sounds. Fullness and rounded qualities. The primary treble octave of musical pitches.
320
Middle C - 260
250
Octave 4: The so-called "mudrange." Transition octave between bass and midrange. Thickness and muddines. Thumpiness. The "tenor" octave of musical pitches. Critical fundamental pitch range. Middle C lives here.
160
125
Octave 3: Upper bass. Musical foundation octave. Bass and lower elements of drum kit have fundamentals here. Critical bottom end range. All speakers play back this octave.
80
Low C - 65
62.5
Octave 2: Lower bass. Sonic foundation octave. Bottom of musical pitches. Primary bass energy. Low C lives here. Most loudspeakers play back this octave.
deep bass infrasound
40
31.25
Octave 1: Bottom end. Little musical content. Effects. Fundamental of kick drum. Mostly not played back by loudspeakers. Very atmospheric, exotic.
20

Figure B: The Ten Octaves of the Audio Spectrum. Given both in terms of the ISO center frequencies (on left) and boundary frequencies. Each octave has its own particular qualities, musically, acoustically and psychoacoustically.

Perfect pitch is a highly developed auditory memory that allows you to identify a given pitch by ear alone. A few people have that memory capability naturally. Most of us can learn it, if we want to. The Golden Ears course does something related to perfect pitch training, in that it teaches and develops your memory for *regions* of the audible spectrum. Where the musician with perfect pitch can say "That note is an E-flat," you will be able to say, "The treble is boosted by 3 dB at 2.5 KHz." This latter ability turns out to be extremely useful. In essence, it gives you the ability to tune your audio system or recording studio, which can be thought of as a musical instrument.

You will learn to identify the qualities of frequencies throughout the audible spectrum, using pink noise and musical examples. This ability is developed gradually. In Volume 1, you will learn the sound of each of the ten octaves in the spectrum. These are the raw materials of frequency out of which we build music, and each one has its own particular characteristics, quality, and musical significance. In recording, handling these octaves is one of our primary tasks.

Some insights about these octave ranges:

- Various musical functions exist in various different ranges. Octaves 2-5 contain the musical fundamental pitches. Octaves above those contain the overtones that are central to defining timbre for musical sounds.

- Overall apparent loudness is very much a function of how these octaves are treated. This is particularly true for octave 7, which contains the frequencies our ears are most sensitive to.

Later on, we are going to release additional materials you can use to learn to identify (to 3 dB accuracy) the magnitude of a change in level of any octave of the spectrum. This skill will then be extended to 1/3 octave resolution.

Another useful direction we will also offer allows you to practice hearing two different octaves of the spectrum modified simultaneously. When you have mastered this, you will have acquired the fundamental ability to mentally scan the audible spectrum and "hear out" spectral elements by ear. You will begin to be able to hear and identify full equalization curves, not to mention the harmonic structures of individual musical sounds. Finally, you can work on drills involving three spectral regions modified simultaneously!

Answer Sheet Templates for Volume 1:

Golden Ears Volume 1, CD 1 - Frequencies answers

This is the first CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying one-octave bands of pink noise or recorded music that have been boosted or cut using a conventional graphic equalizer. The first 12 drill sets involve only a portion of the audio spectrum, making it easy for you to concentrate on learning the sound of a particular portion of the spectrum. Drill sets 13 and 14 involve the entire audio spectrum.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the various octaves of the spectrum.

Please note that Track Cue points occur after the identifying slates and warm-up drills, so that you may select drills at random to test your hearing ability as it develops.

All of us at KIQ Productions gratefully acknowledge and thank the various record companies that have allowed us to use their recorded materials. We urge you to support these companies and buy their records.

Credits

Created and produced by David Moulton
Engineer: Robin Coxe-Yeldham
Assistants: Bill Lee and Dan Ricci
Rights to recorded material granted by:

Boston Skyline Records, Boston, MA
SOL Records, 51 Maxfield Street, West Roxbury, MA 02131 Tel. 617-327-6470
JVC Records, Los Angeles, CA

ANSWERS CD ONE

Drill Set 1

Format: *Lowest five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	63 Hz.	500 Hz.	31 Hz.	250 Hz.	125 Hz.	500 Hz.	125 Hz.	250 Hz.	500 Hz.

Drill Set 2

Format: *Middle five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	2 KHz.	250 Hz.	500 Hz.	250 Hz.	500 Hz.	1 KHz.	4 KHz.	500 Hz.	2 KHz.

Drill Set 3

Format: *Highest five one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	1 KHz.	8 KHz.	2 KHz.	8 KHz.	4 KHz.	8 KHz.	1 KHz.	16 KHz.	2 KHz.	1 KHz.

Drill Set 4 *(Music: Tom Coster: "Gotchall," JVC 2015-2, Band 1.)*

Format: *Lowest five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	63 Hz.	250 Hz.	500 Hz.	31 Hz.	500 Hz.	63 Hz.	125 Hz.	63 Hz.	500 Hz.	250 Hz.

Drill Set 5 *(Music: Signs of Life: "Signs of Life," SOL Records, Track 1)*

Format: *Middle five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	250 Hz.	1 KHz.	250 Hz.	500 Hz.	250 Hz.	4 KHz.	250 Hz.	2 KHz.	250 Hz.	4 KHz.

Drill Set 6 *(Music: Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, Band 1)*

Format: *Highest five one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	16 KHz.	1 KHz.	4 KHz.	1 KHz.	8 KHz.	2 KHz.	8 KHz.	4 KHz.	16 KHz.

Drill Set 7

Format: *Lowest five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	63 Hz.	500 Hz.	31 Hz.	125 Hz.	500 Hz.	125 Hz.	31 Hz.	250 Hz.	63 Hz.

Drill Set 8

Format: *Middle five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	1 KHz.	250 Hz.	500 Hz.	4 KHz.	500 Hz.	1 KHz.	250 Hz.	2 KHz.	4 KHz.

Drill Set 9

Format: *Highest five one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	4 KHz.	16 KHz.	1 KHz.	2 KHz.	4 KHz.	8 KHz.	1 KHz.	16 KHz.	8 KHz.	16 KHz.

Drill Set 10 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 1)*

Format: *Lowest five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	250 Hz.	63 Hz.	500 Hz.	63 Hz.	125 Hz.	250 Hz.	125 Hz.	250 Hz.	63 Hz.	500 Hz.

Drill Set 11 *(Music: Kevyn Lettau: "Simple Life," JVC 2016-2, Band 1)*

Format: *Middle five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	500 Hz.	2 KHz.	1 KHz.	4 KHz.	250 Hz.	500 Hz.	250 Hz.	1 KHz.	500 Hz.	250 Hz.

Drill Set 12 *(Music: Bruno Råberg: "Pentimento," BSD 115, Band 1)*

Format: *Highest five one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	8 KHz.	16 KHz.	4 KHz.	8 KHz.	2 KHz.	4 KHz.	16 KHz.	4 KHz.	2 KHz.	4 KHz.

Drill Set 13

Format: *All ten one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	31 Hz.	16 KHz.	1 KHz.	2 KHz.	63 Hz.	4 KHz.	31 Hz.	4 KHz.	63 KHz.	4 KHz.

Drill Set 14 *(Music: Don Crusin, "Don Crusin," JVC JMI 2010-2, Band 1)*

Format: *All ten one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	4 KHz.	63 Hz.	500 Hz.	8 KHz.	4 KHz.	500 Hz.	16 KHz.	63 Hz.	125 Hz.

ANSWERS CD TWO

Drill Set 1

Format: *All ten one-octave bands of Pink Noise boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	125 Hz.	8 kHz.	125 Hz.	500 Hz.	16 KHz.	4 KHz.	31 Hz.	250 Hz.	31 Hz.

Drill Set 2 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 2)*

Format: *All ten one-octave bands of Music boosted 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	2 KHz.	125 Hz.	63 Hz.	250 Hz.	2 KHz.	63 Hz.	250 Hz.	2 KHz.	31 Hz.	2 KHz.

Drill Set 3

Format: *All ten one-octave bands of Pink Noise cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	1 KHz.	63 Hz.	500 Hz.	2 KHz.	4 KHz.	63 Hz.	250 Hz.	4 KHz.	63 Hz.	2 KHz.

Drill Set 4 *(Music: Alex Acuña and the Unknowns: "Thinking of You," JVCJMI 2006-2, Band 2)*

Format: *All ten one-octave bands of Music cut 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	16 KHz.	125 Hz.	16 KHz.	4 KHz.	63 Hz.	2 KHz.	250 Hz.	31 Hz.	1 KHz.	2 KHz.

Drill Set 5

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+31Hz.	+63Hz.	-500Hz.	+31Hz.	-16KHz.	+31Hz.	-125Hz.	+4KHz.	-31Hz.	-250Hz.

Drill Set 6

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-8KHz.	+4KHz.	+63Hz.	+500Hz.	+4KHz.	-8KHz.	+500Hz.	+1KHz.	-31Hz.	-250Hz.

Drill Set 7

Format: *All ten one-octave bands of Pink Noise boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+16KHz.	-16KHz.	-31Hz.	-4KHz.	+500Hz.	+8KHz.	-4KHz.	-63Hz.	+2KHz.	-4KHz.

Golden Ears Volume 1, CD 2 - Frequencies continued

This is the second CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying one-octave bands of pink noise or recorded music that have been boosted or cut using a conventional graphic equalizer. The first four drill sets each are restricted to either boosting or cutting. The remaining ten sets involve a mixture of boosting and cutting octaves across the entire audio spectrum.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the various octaves of the spectrum.

Please note that Track Cue points occur after the identifying slates and warm-up drills, so that you may select drills at random to test your hearing ability as it develops.

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Boston Skyline Records, Boston, MA
SOL Records, 51 Maxfield Street, West Roxbury, MA 02131 Tel. 617-327-6470
JVC Records, Los Angeles, CA

VOLUME TWO

Effects and Signal Processing

Drill Set 8 *(Music: Signs of Life: "Signs of Life," SOL Records, Track 2)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+8KHz.	-4KHz.	-500Hz.	-2KHz.	+16KHz.	-16KHz.	-250Hz.	+63Hz.	-31Hz.	-8KHz.

Drill Set 9 *(Music: Bruno Råberg: "Pentimento," BSD 115, Band 2)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	+250Hz.	-500Hz.	+250Hz.	-125Hz.	+500Hz.	+125Hz.	-63Hz.	-500Hz.	-250Hz.

Drill Set 10 *(Music: Tom Coster: "Gotcha!," JVC 2015-2, Band 2.)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	+16KHz.	-250Hz.	+31Hz.	+16KHz.	-1KHz.	-4KHz.	+500Hz.	+2KHz.	+125Hz.

Drill Set 11 *(Music: Trio Sonata: "Encore!", BSD 114, Band 1)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-500Hz.	+4KHz.	-125Hz.	+1KHz.	+125Hz.	-8KHz.	-250Hz.	+16KHz	-1KHz.	-4KHz.

Drill Set 12 *(Music: "The Very Best of TRACKS, 1969-1974," BSD 111, Band 4)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+500Hz.	+125Hz.	+1KHz.	-500Hz.	+8KHz.	-125Hz.	-500Hz.	+2KHz.	+63Hz.	-8KHz.

Drill Set 13 *(Music: Seymour Hayden: "Scarlatti by Hayden", BSD 112, Band 1)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	+125Hz.	-125Hz.	+250Hz.	+125Hz.	-500Hz.	+4KHz.	+500Hz.	-31Hz.	+8KHz.	+63Hz.

Drill Set 14 *(Music: Don Grusin, "Don Grusin," JVC JMI 2010-2, Band 8)*

Format: *All ten one-octave bands of Music boosted (+) or cut (-) 12 dB.*

Example #	1	2	3	4	5	6	7	8	9	10
Answers:	-8KHz.	-125Hz.	-500Hz.	+1KHz.	-16KHz.	-31Hz.	-2KHz.	+250Hz.	+125Hz.	-63Hz.

The A/B Drills

Each A/B drill set consists of five examples. Each example is a pair of recorded excerpts of music. The first recording (A) is the "reference" and the second (B) is a clone of the first with some sort of signal processing or audio anomaly added. Your task is to identify the signal processing applied to the B recording.

To assist you, we have limited the number of possibilities to a menu of 31 possible signal processing changes, grouped into six families: amplitude change, distortion, compression, equalization, stereophony and time-delay/reverberation. Also, we have included "no change" as an additional answer, just to keep you honest. Instead of a warmup drill, the first half of CD 3 demonstrates all of these effects for you. The balance of CD 3 and all of CD 4 are A/B drills.

The A/B drills are an effort to instill critical listening paranoia in you and to teach you how to hear and identify small differences between two versions of the same recording. This is an absolutely essential skill for certain aspects of record production work. Trust me! You don't want to be the one to explain that you didn't notice that the reverb return on the right channel dropped out in the middle of the third song and that because you didn't notice it you went ahead and OK'd it for a production run of 5,000 CDs. Such explanations are upsetting for all concerned and it is better for your basic life quality if you don't have to be involved in many such explanations, particularly as the person who has to do the explaining!

Doing the Drills

- Calibrate your system. Answer sheet templates are at the end of this chapter and answer sheet templates at the end of the manual.

- Listen to the demonstration examples on CD 1 of Volume 2. There are thirty-one of them, in six families. Go over them until you are quite sure you can hear the differences described. You will probably find

some of them quite easy, while others will be a little harder. Devote an entire listening session just to the demonstration examples. It will take between 45 minutes and an hour.

- Then, in your next session, cue up Drill Set 1 on CD 1 (beginning with Track 8). Listen to the five A/B examples. For each example, guess both which family of signal processing was used, and which specific menu item it was. On some examples, only one channel is changed. Guess which channel (note that it doesn't have to be the same as the channel used in the demonstration examples).

- After you have completed the five examples, put the CD player in Pause and skip back to Track 8 (Example 1) again. Listen again to reconsider your answers. Skip back and listen a third time, this time writing down the correct answers. At the end of the drill set, hit pause, and score yourself.

- If you guess everything correctly, including left or right channel, give yourself 20 for the example. If you get the channel wrong but have everything else right, give yourself 15. If you guess the right family of effects but have miss the menu item, give yourself 10. Otherwise, it's the big zippo for you. A perfect score for a drill set is 100. If you guess randomly, you should probably get about 7 points. Typical scores are between 45 and 70.

After you have scored yourself, go back and check out the stuff you got wrong. Listen to the A and B version until you can easily pick out the difference.

- Skip ahead to Track 13, the beginning of Drill Set 2. Listen to the five examples, listen again to check your answers, listen a third time while looking at and writing down the correct answers, score yourself if you like, and resolve the examples you didn't get right.

  Two drill sets (ten examples) are enough for any given session.

- Work through the six drill sets on CD 1 and the 12 drill sets on CD 2 of

Hearing Amplitude

The ability to hear a signal as being louder or softer seems obvious, but given that the louder sound usually seems to sound better, it is essential to know when loudness is the ***only*** difference between two signals. That way, you neither fool yourself nor get fooled by some crazed or unethical salesperson. Another possibility I've included here is the gradual change in level. In these examples, the B version starts out identically to the A version, but gradually changes level during the example.

Hearing Distortion

You will learn to recognize THD (Total Harmonic Distortion) in recorded music, in the 10-30% range (pretty gross) and in the 1-10% range (mild). You will probably be surprised to find out that perception of distortion is significantly affected by the music being played, and also by the extent to which harmonic distortion is dependent on level. You also will learn that terms like "10% distortion" are pretty much meaningless on dynamically changing signals, and what we mean to say is something like "the loudest peaks of the recording are probably generating distortion products that are only 20 dB (10% of the amplitude) softer than the peaks themselves."

Hearing Compression

You will learn to recognize the effect of compression on a variety of different signals, and to identify fast and slow compressor release times. This is a fairly difficult area, and probably warrants significant study by itself (another future project). The "musical" impact of compression is a highly variable one, where very slight changes result in dramatically different effects.

Hearing Equalization

You will learn to recognize equalization problems, on either or both channels. This is, of course, related to the spectrum analysis drills you

Volume 2. Then, use the random function on CD 2 to really challenge yourself. Each example has its own track number. Press random and then play; listen to the A and B versions, hit pause, and check the track number on the CD player. Look up the answer. If you didn't get it right, go back over the example until you can hear it. Repeat up to ten times each session.

How These Drills Were Made

The A/B drills were created by recording an excerpt to hard disk from a commercial recording about thirty seconds long. This recording (the A version) is cloned and then passed through one of the thirty-odd signal processing possibilities we have included, and then recorded as a second hard disk sound file. This modified clone is then named "B" and assembled with the slates and "A" to create each example in the drill set. Each example uses different music.

Selection of the signal processing was done in two stages, both random. First, the family of change type was selected, including the possibility of "no change." Then, within each family, a particular change was selected. In the case where the selection involved only one of two channels, selection of Left or Right was also random. The only limit I applied was not to allow two "no changes" in a row.

I continued the practice of adding signal processing to the slates, just as a fun kind of distractor. These have no relationship to the actual examples themselves.

Golden Ears Volume 2, CD 1 - Effects and Processing

This is the third CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying signal processing used to change a recording. The first half of the CD involves examples of 31 different possible signal-processing changes used in these examples. The remainder of the CD consists of drill sets of five examples each.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the signal processing. Keep doing this until you can hear the signal processing used.

Please note that Track Cue points occur after the identifying slates, so that you may select drills at random to test your hearing ability as it develops.

All of us at KIQ Productions gratefully acknowledge and thank the various record companies that have allowed us to use their recorded materials. We urge you to support these companies and buy their records

Credits

Created and produced by David Moulton
Engineer: Robin Coxe-Yeldham
Assistants: Bill Lee and Dan Ricci
Rights to recorded material granted by:

Boston Skyline Records, Boston, MA
SOL Records, 51 Maxfield Street, West Roxbury, MA 02131 Tel. 617-327-6470
JVC Records, Los Angeles, CA

have been doing. For these drills we used on-console equalization rather than a graphic equalizer, and we set controls in ways that we found musically relevant. The details of the individual settings are given in the answer sheets.

Hearing the Stereo Field

You will learn to recognize anomalies in the stereo image consistently (reverse image, mono summation, polarity reversal, and pseudo-stereo). These develop your ability to identify the important and all too frequent errors that appear in our final product: the stereophonic mix. Confidence that you can reliably catch and fix these problems is invaluable.

I generated pseudo-stereo for these examples by using a 10-band graphic equalizer with alternating octaves boosted and cut and the settings of the two channels reversed. The resulting phase shift results in a "phasey" kind of stereo spaciousness.

Hearing Time Domain

You will learn to recognize channel-to-channel time differences over the 1—50 ms. range, and to recognize gated and ungated reverb.

Answer Sheet Templates for Volume 2:

Track 7	Time-delay/Reverb	reverb added	6
	Time-delay/Reverb	reverb deleted	9
	Time-delay/Reverb	gated reverb added	4
	Time-delay/Reverb	gated reverb deleted	9
	Time-delay/Reverb	1 ms. time delay L or R ch.	2
	Time-delay/Reverb	5 ms. time delay L or R ch.	15
	Time-delay/Reverb	15 ms. time delay L or R ch.	7
	Time-delay/Reverb	30 ms. time delay L or R ch.	8
	Time-delay/Reverb	50 ms. time delay L or R ch.	14
Drill Set 1			
Track 8, Ex 1	Amplitude	3 db softer	12
Track 9, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	3
Track 10, Ex 3	Compression	compression, slow release	13
Track 11, Ex 4	Stereo	stereo reversed	14
Track 12, Ex 5	Distortion	gross (10-30%) overload distortion ("clipping")	5
Drill Set 2			
Track 13, Ex 1	Stereo	one channel reversed polarity	11
Track 14, Ex 2		no change	1
Track 15, Ex 3	Equalization	L channel lows (200 Hz.) boosted & highs (10 K Hz.) cut 6 dB	7
Track 16, Ex 4	Equalization	high frequencies (10 KHz.) cut	6
Track 17, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	9
Drill Set 3			
Track 18, Ex 1	Amplitude	3 dB louder	4
Track 19, Ex 2	Stereo	mono to pseudo-stereo	9
Track 20, Ex 3	Distortion	gross (10-30%) overload distortion ("clipping")	15
Track 21, Ex 4	Equalization	L channel lows boosted 6 dB @ 150 Hz.	2
Track 22, Ex 5	Equalization	mid frequencies boosted 6 dB @ 1.5 KHz.	8
Drill Set 4			
Track 23, Ex 1	Equalization	R channel lows boosted 6 dB @ 100 Hz.	2
Track 24, Ex 2	Compression	compression, slow release	15
Track 25, Ex 3	Stereo	one channel reversed polarity	9
Track 26, Ex 4	Amplitude	3 dB louder	4
Track 27, Ex 5	Equalization	mid frequencies boosted 6 dB @ 1.5 KHz.	9

ANSWERS VOL TWO

CD ONE

Track 1: Introduction

Examples	Family	Specific Change	Music
Track 2	Amplitude	3 dB louder	12
	Amplitude	3 db softer	1
	Amplitude	3 dB atten during sample	11
	Amplitude	3 db boost during sample	5
Track 3	Distortion	gross (10-30%) overload distortion ("clipping")	3
	Distortion	slight (1-3%) overload distortion ("clipping")	14
Track 4	Compression	compression, fast release	13
	Compression	compression, slow release	6
Track 5	Equalization	high frequencies cut	9
	Equalization	high frequencies boosted	14
	Equalization	L or R channel lows boosted 6 dB	10
	Equalization	L or R channel lows cut 6 dB	2
	Equalization	L or R channel lows & highs cut 6 dB	4
	Equalization	mid frequencies boosted 6 dB	7
	Equalization	mid frequencies cut 6 dB	8
	Equalization	L or R channel lows boosted & highs cut 6 dB	12
	Equalization	L or R ch. mids & highs cut 6 dB	1
	Equalization	L or R channel mids boosted & opposite channel highs cut 6 dB	11
Track 6	Stereo	stereo to mono	5
	Stereo	mono to pseudo-stereo	3
	Stereo	stereo reversed	14
	Stereo	one channel reversed polarity	13

Golden Ears Volume 2, CD 2 - Effects and Processing

This is the fourth CD in the Golden Ears Audio Ear Training series of recordings. Drills on this CD involve identifying signal processing used to change a recording.

Answers are given below. I recommend that you go back and re-listen to drills you have done while observing the answers to help you "internalize" the sounds of the signal processing. Keep doing this until you can hear the signal processing used.

Please note that Track Cue points occur after the identifying slates, so that you may select drills at random to test your hearing ability as it develops.

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JVC Records, Los Angeles, CA

Drill Set 5

Track 28, Ex 1		no change	1
Track 29, Ex 2	Equalization	high frequencies cut 6 dB @ 10 KHz.	12
Track 30, Ex 3	Equalization	high frequencies boosted 6 dB @ 10 KHz.	9
Track 31, Ex 4	Stereo	one channel reversed polarity	4
Track 32, Ex 5	Compression	compression, slow release	2

Drill Set 6

Track 33, Ex 1	Amplitude	3 db boost during sample	8
Track 34, Ex 2	Time-delay/Reverb	reverb added	14
Track 35, Ex 3	Amplitude	3 db boost during sample	13
Track 36, Ex 4	Compression	compression, slow release	6
Track 37, Ex 5	Amplitude	3 db softer	7

Track 38 Calibration Data

Music Credits:

1	Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, JVC Records
2	Oscar Castro-Neves: "Brazilian Scandals", JVC 2018-2, JVC Records
3	Tom Coster: "Gotcha!!," JVC 2015-2, JVC Records
4	Frank Gambale: "Note Worker", JMID 2001, JVC Records
5	Don Grusin, "Don Grusin," JVC JMI 2010-2, JVC Records
6	Kevyn Lettau: "Simple Life," JVC 2016-2, JVC Records
7	Special EFX: "Play", JVC 2017-2, JVC Records, JVC Records
8	Sadao Watanabe, "Morning Island", JMI 2013-2, JVC Records
9	Signs of Life: "Signs of Life," SOL Records
10	Fifth Estate: "Ding Dong! The Witch is Back!", BSD 116, Boston Skyline Records
11	Seymour Hayden: "Scarlatti by Hayden", Boston Skyline Records
12	Bruno Råberg: "Pentimento," BSD 115, Boston Skyline Records
13	"The Very Best of TRACKS, 1969-1974," BSD 111, Boston Skyline Records
14	Trio Sonata, BSD 110, Boston Skyline Records
15	Trio Sonata: "Encore!", BSD 114, Boston Skyline Records

ANSWERS VOL TWO CD TWO

Track 1: Introduction

Examples	Family	Specific Change	Music
Drill Set 1			
Track 2, Ex 1	Amplitude	3 db softer	5
Track 3, Ex 2	Equalization	R ch. lows cut 6 dB @ 200 Hz.	15
Track 4, Ex 3	Compression	compression, fast release	11
Track 5, Ex 4	Time-delay/Reverb	15 ms. time delay R channel	3
Track 6, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	7
Drill Set 2			
Track 7, Ex 1	Equalization	R ch. lows cut 6 dB @ 200 Hz.	6
Track 8, Ex 2	Distortion	gross (10-30%) overload distortion ("clipping"),	13
Track 9, Ex 3	Stereo	one channel reversed polarity	14
Track 10, Ex 4	Stereo	stereo reversed	8
Track 11, Ex 5	Time-delay/Reverb	5 ms. time delay R ch.	2
Drill Set 3			
Track 12, Ex 1	Amplitude	3 db softer	4
Track 13, Ex 2		no change	9
Track 14, Ex 3	Distortion	gross (10-30%) overload distortion ("clipping"),	12
Track 15, Ex 4	Amplitude	3 dB attenuation during sample	1
Track 16, Ex 5	Equalization	mid frequencies cut 6 dB (@ 2KHz.)	5
Drill Set 4			
Track 17, Ex 1	Amplitude	3 dB louder	15
Track 18, Ex 2	Compression	compression, fast release	11
Track 19, Ex 3		no change	3
Track 20, Ex 4	Compression	compression, slow release	7
Track 21, Ex 5	Stereo	one channel reversed polarity	6

Drill Set 5			
Track 22, Ex 1	Stereo	mono to pseudo-stereo	13
Track 23, Ex 2	Compression	compression, fast release	14
Track 24, Ex 3	Equalization	L ch. lows (200 Hz.) boosted & highs (8 KHz.) cut 6 dB	8
Track 25, Ex 4	Time-delay/Reverb	gated reverb added	2
Track 26, Ex 5	Equalization	L ch. lows boosted 6 dB @ 200 Hz.	4
Drill Set 6			
Track 27, Ex 1	Distortion	gross (10-30%) overload distortion ("clipping"),	9
Track 28, Ex 2		no change	12
Track 29, Ex 3	Stereo	stereo to mono	1
Track 30, Ex 4	Amplitude	3 dB louder	5
Track 31, Ex 5	Time-delay/Reverb	reverb added	15
Drill Set 7			
Track 32, Ex 1	Amplitude	3 dB louder	3
Track 33, Ex 2		no change	11
Track 34, Ex 3	Equalization	mid frequencies cut 6 dB @ 1 KHz.	7
Track 35, Ex 4	Compression	compression, fast release	6
Track 36, Ex 5	Amplitude	3 db softer	13
Drill Set 8			
Track 37, Ex 1	Amplitude	3 db boost during sample	14
Track 38, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	8
Track 39, Ex 3	Time-delay/Reverb	15 ms. time delay R ch.	2
Track 40, Ex 4	Stereo	stereo reversed	4
Track 41, Ex 5	Compression	compression, slow release	9
Drill Set 9			
Track 42, Ex 1	Distortion	gross (10-30%) overload distortion ("clipping"),	12
Track 43, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	1
Track 44, Ex 3	Stereo	stereo to mono	5
Track 45, Ex 4	Equalization	L ch. mids (1K) boosted & R ch. highs (10K) cut 6 dB	15
Track 46, Ex 5	Distortion	slight (1-3%) overload distortion ("clipping")	5
Drill Set 10			
Track 47, Ex 1	Amplitude	3 dB louder	11

Track 48, Ex 2	Equalization	R ch. lows boosted 6 dB @ 200 Hz.	7
Track 49, Ex 3	Distortion	slight (1-3%) overload distortion ("clipping")	6
Track 50, Ex 4	Amplitude	3 dB louder	13
Track 51, Ex 5	Amplitude	3 db boost during sample	14

Drill Set 11

Track 52, Ex 1	Equalization	high frequencies cut 6 dB @ 8 KHz.	8
Track 53, Ex 2	Time-delay/Reverb	15 ms. time delay L ch.	2
Track 54, Ex 3	Equalization	mid frequencies cut 6 dB @ 2 KHz.	4
Track 55, Ex 4	Equalization	R ch. lows boosted 6 dB @ 100 Hz.	9
Track 56, Ex 5	Stereo	stereo reversed	12

Drill Set 12

Track 57, Ex 1		no change	1
Track 58, Ex 2	Distortion	slight (1-3%) overload distortion ("clipping")	5
Track 59, Ex 3	Stereo	mono to pseudo-stereo	3
Track 60, Ex 4	Time-delay/Reverb	50 ms. time delay R ch.	7
Track 61, Ex 5	Amplitude	3 dB attenuation during sample	6

Track 62 Calibration Data

Music Credits:

1. Alex Acuña and the Unknowns: "Thinking of You," JVC JMI 2006-2, JVC Records
2. Oscar Castro-Neves: "Brazilian Scandals", JVC 2018-2, JVC Records
3. Tom Coster: "Gotcha!!," JVC 2015-2, JVC Records
4. Frank Gambale: "Note Worker", JMID 2001, JVC Records
5. Don Grusin, "Don Grusin," JVC JMI 2010-2, JVC Records
6. Kevyn Lettau: "Simple Life," JVC 2016-2, JVC Records
7. Special EFX: "Play", JVC 2017-2, JVC Records, JVC Records
8. Sadao Watanabe, "Morning Island", JMI 2013-2, JVC Records
9. Signs of Life: "Signs of Life," SOL Records
10. Fifth Estate: "Ding Dong! The Witch is Back!", BSD 116, Boston Skyline Records
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13. "The Very Best of TRACKS, 1969-1974," BSD 111, Boston Skyline Records
14. Trio Sonata, BSD 110, Boston Skyline Records
15. Trio Sonata: "Encore!", BSD 114, Boston Skyline Records

Problems, Suggestions and Comments

Over the years there have been several routine comments that students have made about the drills that I would like to discuss in order to ease your mind.

1. "The equalization drills can be tough to hear, especially octaves 1 and 10."

The equalization drills involve all ten octaves of the audio spectrum. Because the examples are chosen at random, the octave centered at 31 Hertz is often involved. What you will soon discover is that most loudspeakers don't do much below 40 Hertz and most recorded music doesn't have much energy down there either. So, such examples are hard (impossible, sometimes) to hear. In keeping with the realities of the real world, that's life. Remember to guess!

2. "The slates are really annoying."

Comments (including some remarkably rude ones), suggest that my slates are a distraction, particularly with the A/B drills. There is a reason: auditory memory fades quickly, and the drills become much easier (too much so, in fact) if the transition from A to B is very quick. Again, real life doesn't work that way: the problems usually occur *while* two people are talking to you *while* you eat a hamburger in the doorway of the studio *while* an automated mix is being made. ***That's*** when you need to be able to hear the aforementioned reverb return drop out. So, the slate is intended to serve as a buffer, a distractor, between the two examples.

3. "It's really hard to hear the stereo examples!"

Many of the A/B drills that involve stereo/mono, polarity reversal, change on one channel only, etc. are mainly audible along the median plane and barely audible anywhere else in the room. This is an important lesson to learn. If you sit off to the side of the median plane, you are going to be in trouble.

The median plane (as taught in high school geometry—it had to come in handy sometime) consists of all points equidistant from each speaker. Anything more than a couple of inches off the median plane will do grievous damage to the stereo illusion, particularly for critical listening and stereo audio mixing.

As an audio pro, learn to fight for a seat on the median plane: your career may depend it!

4. "What is The Secret to acing these drills in nothing flat?"

Frankly, I think intuitive guessing (snap off the answer quickly, without thought, as soon as you hear the stimulus) works pretty well, particularly as you gain experience. When pink noise is the signal source, characterizing the octave bands (2 kHz. as a leaky steam fitting, 63 Hz. as a distant jet engine, for instance) works pretty well. However, this labeling technique has its dangers when you get into program material, because your pet noise characterizations may not align with the instrumental timbres you are listening to. Over the long run, I personally have tried to memorize a sense of "highness" or "lowness" for each octave band, and found this works quite well in real life. If you have a sense of the "sound" of an octave band (and the sound of its absence) firmly fixed in your ear-memory, it is quick work to move into the equalization realm to fix problems during recording sessions.

For the A/B drills, I think you have to hang loose, and let the answers come to you. (How's that for pseudo-Zen?) You do this by relaxing, letting yourself notice that there is a difference, and then intuitively guessing what the difference is (the most terrifying thing about these drills is that often you can't hear a difference at first). Sure, you'll be wrong a lot, but the trick is to *notice that there is a difference*. Once you can do that, the rest is fairly easy. Remember, there is no way that you can *learn and know* all the differences in your mind beforehand by brute intellectual force.

The drills all involve self-scoring, if you care to indulge. Keep in mind that

this is not a competition, and just because you score in the high 90's doesn't mean that you have better hearing than some other poor schlumpf. What it means is that you are more effectively recognizing and articulating what you are hearing than you were when you were scoring in the low 80's. So, the drills aren't tests, and the strictly optional scoring is for your own information and critical evaluation.

History of These Drills

I started giving these ear training drills to individual students and small classes in my own recording studio in the early 1970s. The method is based on traditional musical ear training methods that were inflicted on me in music school (Juilliard), but with as much of the terror removed as possible. (Some music schools used to treat ear training as a rite of passage, an initiation-by-humiliation ritual.)

As some of you may know, in traditional music ear-training, students practice hearing and identifying intervals, chords, melodies, rhythms and counterpoint. "Taking dictation" (Gulp!— I still cringe in fear, just thinking about it!) meant listening to the teacher play something and writing it down by ear. The beginning part of this training was simply identifying intervals and chords. It is from that basic practice that I developed these drills. I've found that the terror part of ear-training is not only unnecessary, but actually counterproductive, and that by being friendly and supportive about it my students (that's you, now) progress quickly and enthusiastically.

So, when you do the drills in Volume 1 you will be doing the equivalent of identifying intervals and chords: you will be learning to identify regions of the audio spectrum. Volume 2 includes drills to help you learn to discern signal-processing (I call them A/B drills), and after that there will be increasingly challenging spectrum drills, to a point where you should be able to hear and identify complete equalization settings by ear. That's right, you should be able to listen to an equalizer switched in and out on a recording and describe how the equalizer is set, in terms of frequencies and the amount of boost or cut, by ear alone!

These drills have evolved somewhat over the years, and have achieved a certain amount of renown. National Public Radio has used them as part of the training for their production and engineering personnel, and I have used them in a variety of college programs, including the Music Production and Engineering program at Berklee and the Tonmeister Studies program at the State University of New York, College at Fredonia. In addition, they have been used by faculty at UCLA, New York University, the Danish Acoustical Institute, and NBC. At present, I am developing a full course in critical listening based on these drills for Emerson College in Boston.

There are other people also working on critical listening skills for music and audio. Alton Everest and Tom Rossing have released some excellent auditory demonstration recordings. Their recordings are intended to demonstrate the audible effect of various signal processing operations and psychoacoustic effects. Andresj Miskiewicz, currently at Northeastern University in Boston and formerly at the Chopin Academy in Warsaw, Poland, has developed a wonderful and very powerful curriculum that he calls *Auditory Solfege*. This is an active ear-training curriculum (you need a teacher and a fair amount of hardware to do it) for recording engineers that involves an elaborate array of exercises and training. After three years of study, you can hear and identify just about everything! Will Moylan, at the University of Massachusetts at Lowell, has developed an auditory skills course that involves analytical listening and notation of recorded sounds that is generally related to the "taking dictation" part of conventional music ear-training. Check out his book, *The Art of Recording: The Creative Resources of Music Production and Audio.*

My drills are a series of exercises intended to help you learn how to identify sound characteristics under a wide variety of circumstances, by ear alone. Through practice on drills of increasing levels of difficulty, they allow you to develop hearing skills and the ability to describe sounds to a point fairly close to the limits of auditory discrimination for frequency and amplitude. They are designed for home use, and to be extremely user-friendly. All you really need is a CD player and moder-

ately decent speakers or headphones. After you've gone through and mastered the drills in Volumes 1 and 2, you should be able to describe the response curve of any given system, as well as the control settings on an equalizer, the amount of delay on a time-delay line, and the settings on a compressor or noise gate. Further, you should be able to pick out most regular signal processing with considerable confidence.

This audio ear-training can be fun, in a weird kind of way. You will find that it can easily arouse your competitive instincts, and you may come to delight in impressing your friends at parties with your new-found high-tech vocabulary, as in, "The zither seems to be down two dB at 750 Hz. and there's about 4% Total Harmonic Distortion on the second harmony bagpipe track. Oh, and by the way, the mid-range driver on the left speaker is wired out of polarity." However, audio ear training is much more than a game. You really cannot expect to make professional quality music without such skills. Intelligent hearing (AKA Golden Ears) is a basic tool you should have in your bag of audio goodies (next to the red Sharpie, the Etymotic Ear Plugs and the Tylenol).

Objectives of this study

The Ear as an Acoustical Test Measurement Instrument

The human auditory system is a remarkable sensory system, capable of observations and discrimination that equal or exceed all but the most elaborate testing equipment we've been able to build to measure sound. Therefore, it is possible for us to use our hearing as a test instrument, once we figure out how to articulate what it is we are hearing. The ability to accurately describe the physical nature of what we are hearing is a primary objective of the Golden Ears Drills.

Ear Training and Learning

There is also a higher-level "Zen of learning" aspect to all ear-training. Musical sound is generally perceived in the right hemisphere of the

brain as "spatial" or holistic patterns, and as such is not generally available to the "verbal" left brain for conscious verbalized description. This is part of the difficulty with ear-training. Although the actual act of perception is fairly easy, it exists in a realm of our consciousness that doesn't have words.

(If you are curious about this right brain/left brain business, check out Tom Blakeslee's excellent book for normal people, *The Right Brain.*)

Nonetheless, you can certainly learn to describe what you hear, and the ability to effectively articulate audio issues is priceless in our field. The clumsy, inarticulate conversation that takes place among musicians, engineers, and producers, such as "Can you like, make, the guitar a little fluffier, y'know what I mean?" seriously interferes with their creative efforts.

Being Able to Speak Accurately About What You Hear

As you become fluent at this, you will be able to easily note many things about a recording, quickly and apparently effortlessly. You will be able to "hear through" the recording much better, identifying signal processing, level problems, etc. with little trouble.

How Good Can Your Ears Get?

A couple of years ago, a colleague of mine, who likes to complain that he is going deaf in one ear and can't hear anything high in the other, knocked the proposed CBS Copycode scheme (which was allegedly inaudible) right out of the ballpark by identifying it 100% of the time in controlled double-blind tests conducted by the National Bureau of Standards. Once he astounded me by identifying, by brand and model, the side microphone I had used in a middle-side stereo recording I was playing for him, and noting (correctly, as I found out to my chagrin) that it was not functioning to spec! And yes, he has done these drills!

When you get the hang of doing these drills, the stuff you can hear will

seem equally magical to others, and your ability to quickly and surely arrive at the sound you need will seem remarkable to them. To you, it will be obvious and intuitive. You will have Golden Ears.

A Few Warnings

The Challenge

Try not to lose self-confidence when working on your Golden Ears. It can be a slow process of learning, and you may occasionally get stuck and feel like you aren't progressing. Stick to it and pace yourself. Just as when you learned to ride a bicycle, you learn this stuff through repeated failures.

Also, I think it is really important to go over this stuff *with the answers in hand* repeatedly until you are sure you actually can consciously identify the sounds we are studying. You will often get lost, will not be able to hear a change, or will hear something else (a boost in EQ will of course make something louder— the trick is to know that it wasn't just louder, but louder at a specific part of the spectrum). You will get frustrated and tired sometimes. Keep the faith! It's like learning to ride a bicycle!

Getting Lower Scores While You Are Getting Better

The nature of the drills is such that as you progress, the drills get harder. If you bother to score yourself, you may notice that your scores keep getting worse. Don't be discouraged. To use a golf analogy, the drills start out as all Par 3 and progress to being all Par 6! Don't expect to be getting Par 3 scores on Par 6 exercises!

If you need a quick ego boost as you get mired down in some of the more advanced stuff, go back and try the earlier, easier drills. For instance, after you've been trying to guess that B has attenuated 3 dB during the exmple, you will find that pink noise boosted 12 dB in one octave band is *really disgustingly easy.*

About Monitors

There is no such thing as a perfect monitoring environment. Because these exercises utilize the *entire audible spectrum*, weaknesses in your monitoring system will be exposed. This is exacerbated by the fact that you are performing extremely critical listening. The solution here is to simply ***do*** your ear training, accepting and compensating in your mind for the apparent frequency response deficiencies introduced by your monitors. In fact, the audio recordings you produce or listen to will be played on countless different systems, many of which are probably inferior to your monitoring set-up. Learning to compensate mentally for deficiencies in the monitoring space is part of training your Golden Ears.

Changing Ears

As you start this drill work, you will notice that your perception of sounds changes. For a while, it may be a little disconcerting, and you should be mentally prepared for this. As you begin to internalize the audible spectrum, you will start hearing everything in terms of octaves. You roll down the car window at seventy (er, fifty-five, I know, I know) and hear Octave 2 (63 Hz.) instead of wind buffeting. You tune in a sports event and instead of crowd roar you hear Octave 5 (500 Hz.). Instead of a light metallic edge on an acoustic guitar you hear Octave 9 (8 kHz.)!

Also, the A/B drills will make you so paranoid about each little nuance that you will start listening to just the spaces *between* the sounds. For a while, you will find you stop hearing the music and instead hear only the reverb, the sonic detailing, the delays, the release trails and attack pumping of compressors. Whew!

This goes away, sort of, after you have acquired and internalized these Golden Ear skills, so that your original musical focus and subjective enjoyment comes back. But you will also have an added dimension, a hearing acuity that allows you to hear your way into and through the

sounds in a way that you never could before, forever altering your sense of what sound is and can be.

Tarnished Ears?

Do not panic if you find you can not hear above 19,995 Hz. Lots of students have come to me in terror because they can't hear some high frequency and are sure their career is over! In fact, the half-octave bout 15 kHz. isn't terribly significant musically and isn't played back by all that many audio systems.

We often refer to the audible spectrum as 20 Hz. to 20 kHz., but those stated limits are really just convenient values for us to remember. A more functional definition of the useful audible spectrum for music recording might be 40 Hz. to 15 kHz. In addition, the fact that you are in the audio engineering field at all suggests you have had above average exposure to sound at loud levels (in the studio, attending/working concerts, etc.). So it is possible that you may even have slightly reduced acuity at some frequencies. Additionally, we aren't all born equal. Women, in my experience, seem to have greater sensitivity to high frequencies and to harmonic distortion than men. Individual variances between people are significant as well. Don't worry! Knowing more specifics about what you can and cannot hear will improve your critical listening skills. You can be sure that many of the engineers whose work has sold millions of records have done it with hearing that is physiologically far from perfect. The colleague I mentioned above is a classic example.

Tired Ears

Ah, yes. Tired ears are also tired brains. And when you are tired, you can't hear very well, in a critical listening sense. You can't do these drills for very long, just as you can't expect to work totally creatively and productively for sixteen hours at a stretch. The perceptual job is just too tough, and you've got to accept the limitations of your own particular attention span.

How do you know when you are tired? When louds don't seem loud anymore, and you feel the urge to ***really crank it up*** to give you a little shot of adrenalin. We all like to crank it up, of course, but I suggest that you limit it to the occasional recreational abuse, at home. Don't do it as a professional practice.

Another sign that you're getting tired is when you begin to get confused, bored, or impatient, which is nature's way of telling you it's time to stop. Work on this stuff only for as long as you can really *focus* on it.

In Closing...

As your experience develops, your confidence in recording, mixing, production, and listening sessions will go way up. That's because you can not only hear, but also describe what you hear in physical quantities, saying "the toms are boosted 6 dB at 250 Hertz" instead of "the toms sound tubby," or "the piccolo is down 3 dB at 500 Hertz," instead of "I think the piccolo sounds thin"

This business is really about sound, and this is the best doorway into sound that I know. So don't let the Audio Devils get you. May the Force be with you, and remember, if you can't hear it, it's probably 31 Hertz being cut! Good luck!

Dave Moulton
Groton, MA

PS: We'd really like to hear from you about these drills. We're open to suggestions, improvements, etc., and would just like to talk to anybody that has bothered to read this far! So, please write or call if you have questions, comments, complaints, or suggestions.

As you know, we have more drills on the drawing boards. Is there anything in particular you would like? We are also looking at CD-ROM and CD-I. Any thoughts?

Thanks again for your interest.

Just write to:

KIQ/Golden Ears, 13351-D Riverside Drive,
Sherman Oaks, CA 91423

or call us at 818-905-5432

Acknowledgments

I'd like to thank a bunch of people for their support. In the beginning, at Dondisound Studios, Greg Becker and Tom Swift gave me a tremendous amount of help. Too many wonderful students to mention by name at SUNY/Fredonia suffered through early versions and gave me much help and guidance (it used to be a weekly ritual— ear training at 6 PM every Monday for the Tonmeister students). At National Public Radio, Skip Pizzi, Neil Muncy, Paul Blakemore, Curt Wittig, Elaine Salazar, Dave Glasser, and Terry Skelton all provided great help and support. At Berklee, I'd like to specially thank Tony Dibartolo, Mark Wolinski, Mark Hutchins, Robin Coxe-Yeldham, Wayne Wadhams, Carl Beatty, and Mitch Benoff, not to mention Alex Hodge and Peter Alhadeff. At Home and Studio Recording Magazine, thanks to Nick Batzdorf for encouraging me to go ahead with this project. And especially, thanks to my wife June, who used to do these drills on the sly out in the office while I was doing classes in the control room at Dondisound, and who has listened to more pink noise than anyone should ever reasonably have to! Thanks again to all of you!!

Golden Ears Volume 1 Ear Training Drill Answer Sheets

Drill: Boost or Cut Pink Noise or Music 12 dB

Instructions: After a warmup demo, you will hear 10 examples of Pink Noise or Music being boosted or cut in 1-octave bands by 12 dB. You guess which octave is being boosted or cut. Answer in the row labeled "Your answer."

Enter the correct answer in the next row. Score according to instructions. Add your scores up for Total.

Be sure to indicate whether each example is boosted or cut, as well as which octave is involved.

The following five pages are templates—feel free to Xerox them at will.

About the author

Dave Moulton has degrees in music from Bard College and the Juilliard School of Music. He has taught music, audio, and acoustics at a variety of colleges, including the State University of New York, College at Fredonia and Berklee College of Music, where he has served as Chair of the Music Production and Engineering Department. He is currently on the faculty at both the University of Massachusetts at Lowell and Emerson College in Boston. During the 1970s he owned and operated Dondisound Studios, a commercial recording facility in upstate New York. He has been active in acoustics and loudspeaker design and shares in several patents pertaining to loudspeakers. He is currently a writer for *Home and Studio Recording Magazine*, and is completing a book on music recording. Dave is active as a composer and recording engineer.

Answer sheet template — Volume One, Frequencies

Reference guide to octaves and frequencies

Octave	1	2	3	4	5	6	7	8	9	10
Ctr. Freq.	32	63	125	250	500	1000	2000	4000	8000	16000
Range	20-40	40-80	80-160	160-320	320-640	640-1.25K	1.25-2.5K	2.5-5K	5-10K	10-20K

Drill Set# _____

Example#	1	2	3	4	5	6	7	8	9	10	
Your answer:											
Correct answer:											Total score:
Score:											

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Score 10 points for each correct family
Score 10 points for each correct identification of A/B difference
Take 5 points off for guessing the wrong channel

FAMILY	ACTUAL A/B CHANGE
Amplitude	3 dB louder
Amplitude	3 db softer
Amplitude	3 dB attenuation during sample
Amplitude	3 db boost during sample
Distortion	gross (10-30%) overload dist.
Distortion	slight (1-3%) overload distortion
Compression	compression, fast release
Compression	compression, slow release
Time-delay/Reverb	reverb added
Time-delay/Reverb	reverb deleted
Time-delay/Reverb	gated reverb added
Time-delay/Reverb	gated reverb deleted
Time-delay/Reverb	1 ms. time delay L or R ch.
Time-delay/Reverb	5 ms. time delay L or R ch.
Time-delay/Reverb	15 ms. time delay L or R ch.
Time-delay/Reverb	30 ms. time delay L or R ch.
Time-delay/Reverb	50 ms. time delay L or R ch.
Equalization	high frequencies cut
Equalization	high frequencies boosted
Equalization	L or R channel lows boosted 6 dB
Equalization	L or R channel lows cut 6 dB
Equalization	L or R channel lows & highs cut 6 dB
Equalization	mid frequencies boosted 6 dB
Equalization	mid frequencies cut 6 dB
Equalization	L or R channel lows boosted & highs cut 6 dB
Equalization	L or R ch. mids & highs cut 6 dB
Equalization	L or R channel mids boosted & opposite channel highs cut 6 dB
Stereo	stereo to mono
Stereo	mono to pseudo-stereo
Stereo	stereo reversed
Stereo	one channel reversed polarity
	no change

Golden Ears Audio Ear Training Drill Answer Sheet: A/B Drills

*Name*_____

Track	Guessed family	Guessed specific change	Correct family	Correct specific change	Score
				Total score:	

*Name*_____

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